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Owing to pressure on our space we have found it necessary to omit "Selected Articles" in this issue.

The following Original Articles will appear in our next issue (July 1919).

HIS EXCELLENCY THE RIGHT HON'BLE THE EARL OF RONALDSHAY, G.C.
Governor of Bengal.

Photo by Johnston & Hoffmann.

Original Articles.

NITROGENOUS FERTILIZERS: THEIR USE IN INDIA.

BY

C. M. HUTCHINSON, B.A.,

Imperial Agricultural Bacteriologist.

THE following paper was read by the Agricultural Adviser to the Government of India, in the absence of the writer, at the recent meeting of the Indian Science Congress at Bombay. It elicited a considerable discussion and we shall be glad if readers of the Journal will favour us with their views on the important points of principle it raises.—[EDITOR.]

MY intention in writing this paper is in no wise to provide a tatistical review of the nitrogen requirements of India as an agri-ultural country with tables of figures showing the number of tons f nitrogen exported in the form of hides, oil-seeds, bones or salt-petre, and imported as manures, but rather to present one or two spects of the general problem connected with the use of nitrogenous ertilizers in India as they appear to one who has had some consider-ible experience of the point of view of the agricultural chemist and f the soil biologist. The principal questions that seem to suggest hemselves are—

(1) Does India require nitrogenous fertilizers, and

(2) Can the country afford to pay for them?

Now the answer to the first question is by no means the simple and emphatic affirmative that would be given in the case of such a

country as England, and would also generally be given for India or any other country by experts unfamiliar with all the facts of the case as we know them, or should know them here. In the short time at my disposal for writing this paper it has not been possible for me to make any review of soil conditions outside those familiar to me in North-East India, and for this reason, as I said before, I am merely putting forward a view based on my own experience in order that you may consider how it accords with your own, and point out in discussion, perhaps, how singularly wide of the mark it is when applied to cases within your knowledge.

What I suggest, then, is this, that in the case of a large proportion of soils under arable cultivation in India, nitrogen supply is not to be regarded as the limiting factor so much as that of either phosphates, potash or lime, and that the use of nitrogenous fertilizers by themselves may readily lead to a lowering of fertility by exhaustion of the available quantities of these other mineral constituents of plant food. This argument of course is absolutely elementary and axiomatic, but I make no apology for introducing it as there is a large amount of evidence of its neglect on the one hand and of ignorance of its importance on the other. We find for instance planters of experience (I mean Europeans) firmly holding the belief as a body that in dealing with perennial crops—"once manure, always manure." Analyse this belief and you will discover that the planter's experience is that if you encourage the growth of a plant by nitrogenous manuring, the yield in successive years will fall below the normal unless stimulated anew by fresh applications of manure, which he cannot as a rule afford to give. In most cases further analysis will show that the planter holds the view that this result is a natural consequence of his soil having acquired a sort of vicious drug habit for nitrogen, requiring repeated and increasing doses to produce any observable effect. This attitude is by no means so improbable or uncommon as it appears and is also not at all unknown amongst quite well educated farmers in England, but the latter in most cases know how to remedy the defect by complete manuring, and many do so in full knowledge of the fact that the apparent falling off in the normal condition of the

plant is due to the unwonted drain upon the mineral resources of the soil as a consequence of the greater growth induced by the nitrogenous stimulant. The Indian cultivator on the other hand is very generally averse from the use of nitrogenous manures except in the case of rice and sugarcane, and such manures as he employs are generally either cakes or green manures, the former of which supply phosphates and potash as well as nitrogen, whilst the latter, although their stimulating effect is mainly due to their nitrogen content, supply such small quantities that this stimulation is of a low order and not comparable in soil exhausting power with that of other manures of high nitrogen content. As is well known, the ryot generally uses cowdung as fuel rather than as manure so that this source of nitrogen is lost to the soil and this practice actually constitutes a highly serious factor in the nitrogen deficiency of Indian soils generally. In Bihar the ryot has at hand a nitrogenous manure in the form of saltpetre, but although this is easily obtainable, specially in the crude unrefined condition as the "shora" of the *muniah*, it is not used as manure even for valuable crops. This seems remarkable, especially as the *muniah* who makes it is almost invariably a cultivator as well, or at least one or more of his family are; the reason invariably given, however, is that the use of saltpetre results in the loss of *tāqat* by the soil, and that the only remedy for this condition is fallowing, implying the loss of a crop.

Here then we have the attitude of the ryot towards nitrogenous manuring based on his practical and inherited experience. His scheme of farming depends upon getting a continuous series of crops, presenting low yields from the soil, but by reason of this lowness avoiding loss of *tāqat* or reduction in fertility. For the same reason the Indian cultivator, in such a tract as Bihar where cultivation has reached a high pitch of perfection, is chary of using high yielding varieties of crops or of carrying cultivation, in the sense of ploughing and harrowing, to a high degree because he knows that the large crop or series of crops will inevitably be followed by correspondingly small ones.

Finding such a belief firmly rooted in the minds of the cultivators in such a tract as North Bihar where the fertility of the soil is so

great as to allow it to carry one of the densest rural populations in India, one is naturally led to inquire into the causes underlying it. Various limiting factors in crop production are found at once, of which the most prominent is water supply; the Bihar cultivator is a past master both in the art of conservation of soil moisture and of securing its proper vertical distribution at sowing time, and, in common with all other Indian agriculturists in non-irrigated areas, looks upon the distribution of rainfall as the primary factor in determining crop production. It is interesting to find that in Bihar the pessimistic general outlook of our British farmer so far as weather is concerned finds its counterpart in the belief that a good year is generally followed by a bad one, not necessarily because of the improbability of two successive years of good weather, but once more because of the exhausting effect of a bumper crop upon the soil. Here again the ryot hopes for nothing better than a medium crop on an average of years and shows his conviction, based on generations of experience, that there is some, to him quite natural, adverse influence which rules and limits production. We, with our advanced knowledge of agricultural chemistry and biology, can say with some probability of correctness to what this adverse influence is mainly due, but can we do anything to neutralize or remove it? *Felix qui potuit rerum cognoscere causas*; but is it not possible that we may discern a cause without fully understanding its effect? Let us take the case of nitrogen as one of the most prominent factors in soil fertility.

Here we have an element existing in the soil sometimes in large quantities, only a small fraction of which is available at any one moment as plant food. Availability depends upon nitrification, and this again depends upon a complete series of chemical changes due to bacterial action, starting with the proteid nitrogen of the plant cell, as found in the organic refuse of the soil, and going through such stages as peptones, polypeptids, amino-acids and ammonia to the final condition of nitrites and nitrates. Now there appear to be points in the early parts of this series at which the style of decomposition may diverge from its natural orderly progression into side-tracks leading to the formation of compounds which do not

eadily lend themselves to further progress to the goal of nitrifica-
ion ; consequently we have a natural tendency in the soil towards
he accumulation of residual masses of nitrogenous organic matter,
nd were it not for this tendency there appears to be no reason why
he greater part of the nitrogen in the soil should not be nitrified
multaneously instead of only a small fraction. It is a well-known
ct that in peat soils the relative proportions of carbon and nitrogen
ary as the peat becomes older, the carbon becoming relatively
ss and the nitrogen relatively more. This is also the case to a less
egree in all uncultivated soils. This condition in peat soils is no
oubt due to the influence of the semi-anaerobic conditions charac-
eristic of such soils during their formation upon the kind of bacterial
ction responsible for decomposition of the nitrogenous organic
natter they contain, and in all soils the relative amounts of nitrate-
itrogen and of reserve nitrogen will vary in accordance with the
eration or otherwise of the soil itself. When we increase the appa-
ent fertility of the soil by draining and intensive cultivation we are
imply using up reserve nitrogen at a rapid instead of at a slow
ate, and unless steps are taken to replace it at the same rate, sooner
r later depreciation in the fertility of the soil will inevitably occur.
ut in very many cases exhaustion of some other constituent such
s P_2O_5 occurs first and even careful green-manuring, which may
ostpone nitrogen exhaustion for some time, is unable to avoid
his result. Another frequent failure is that of the non-nitrogenous
ganic matter of the soil which is rapidly destroyed by intensive
ltivation, and the loss of which is only with difficulty made good
green-manuring or caking ; one great evil of such loss, apart
om the obvious one of destruction of tilth, is the interference with
e natural fixation of nitrogen by nonsymbiotic soil organisms.
his highly important source of soil nitrogen requires careful investi-
tion, especially in India where climatic conditions and the high
mperature of the soil enormously enhance the activity of soil
cteria and with it the importance of such methods of adding to
rtility as depend upon their action. At Rothamsted fixation
nitrogen by nonsymbiotic soil organisms has been shown to add
arly 100 lb. per acre per annum to an uncultivated soil ; at Pusa

this amount has been greatly exceeded, but in this case artificial additions of carbohydrate were made so that we have only an indication of the potential activity of azotobacter under optimum conditions. The point to be emphasized however is this: neither at Rothamsted nor at Pusa has such a high rate of nitrogen fixation been observed in soils under arable cultivation, even making allowance for the nitrate formed and removed either by the crop or by drainage. Fixation no doubt goes on in cultivated soil but its rate is probably lowered by the want of sufficient carbohydrate to allow of its proceeding at a maximum pace. In a fallow or uncultivated soil such carbohydrate accumulates along with the organic matter formed by wild vegetation or algal growth, but cultivation lowers the supply, and the better the cultivation and the more complete the drainage and aeration so much lower will be the quantity of food available for nitrogen-fixing organisms in the soil. Here we have another instance of the necessity of due consideration in introducing a Western method into the East. In England complete drainage and cultivation are the foundations of successful farming; in India although the same operations will generally result in an increase of crop and of apparent fertility, yet the ultimate result may easily be depreciation in the condition of the soil due to over-rapid formation of nitrates and their loss in drainage water and to the rapid decrease in the content of organic matter in the soil accompanied by loss of tilth and of nitrogen-fixing power.

Apart from the deleterious effect of over-cultivation upon fixation of atmospheric nitrogen, the lowering of the content of organic matter in the soil by this means has another less direct effect in reducing the numbers of soil bacteria and thereby lessening the valuable influence they exert upon the retention of soil nitrogen. Where organic matter is plentiful these bacteria will be sufficiently numerous to reconvert any excess of nitrate formed into proteid nitrogen and thus prevent its leaching out of the soil by rain as happens in over-cultivated and over-drained soils. Thus in order to avoid loss of tilth and of organic matter, reduced fixation of nitrogen and formation of nitrate, a proper mean must be struck between excessive cultivation which will give large crop yields

it reduce fertility, and no cultivation at all; this is in cases here manure is unavailable or is too costly, but my object in tering this warning is to point out the absolute necessity of realiz- g the facts of the case connected with the utilization of inten- re cultivation and especially of improved high yielding varieties, d of co-ordinating the activities of the Agricultural Department that the plant breeders shall not be in a position to say: "We have ven you improved machinery for making use of solar radiation, here is the raw material necessary to keep it in operation?" repeat therefore that in such a tract as Bihar experience shows at the introduction of intensive methods (sometimes referred as improved methods) of cultivation and of heavy yielding varie- s of crops, is necessarily followed by reduction in the reserve d supplies of the soil and sooner or later by reduced fertility. is loss of fertility is by no means confined to Bihar; similar nditions may be found from the Punjab to Assam. It follows erefore that unless India is to be content to produce crops at a e determined for each soil by the nitrogen-fixation rate in that l and thus to give up the advantages of improved varieties of ps, nitrogenous manures are necessary in this country just as y are elsewhere. Research and experiment will no doubt show how to make the most of our existing nitrogen supply and even w to increase its amount by improving the conditions for fixation, her symbiotically or asymbiotically, but my opinion is that our proved machinery for converting soil nitrogen into crops is even w considerably in advance of the supply of raw material and is ely to become more so in the future. As I have pointed out ore, nitrogen is by no means the only limiting factor and any empt to provide this element alone will merely result in more id depreciation of a large majority of our soils. Although inten- e cultivation will rapidly bring into an available condition large ounts of the reserve nitrogen of the soil, it appears more difficult produce the same result at anything like the same pace so far as mineral constituents are concerned. Solubilization of such stances as natural phosphates, whether existing as constituents the original mineral particles of the soil or in organic combination

as plant residues, is a process depending largely upon bacter action the slowness of which is frequently indicated by the differen between the " available " and total phosphates in the soil chemis analysis. Some experts, mostly in America, have asserted th the soil solution always contains sufficient minerals, such as pho phates, to satisfy the food requirements of the crop, but this theor cannot be considered tenable in the light of general experience wit manures, and especially of work at Rothamsted on this particu point. We come back therefore to the fact that if nitrogen is ma available more rapidly, relatively as plant food, than miner such as phosphates, the available supply of the latter will be exha ted and infertility result.

We have then two natural sources of available plant food soil, both depending upon slow biological processes going on in t latter and setting a natural pace for crop production; any artifi interference with the parity of these processes must result in lowering of fertility only to be avoided by judicious manuring or r covered from by fallowing, or manuring, or both. It must be not also that application of phosphates without regard to the sufficien of the nitrogen supply may do great harm by bringing crop grow above the safety point which should properly be fixed by th natural limiting factor.

Let us now turn to the second question: Can India pay fo the nitrogenous or other manures which I have endeavoured t show are necessary? This of course is entirely a question of th relative values of increase of crop and cost of manure, and it i one which requires not only consideration of local values as the exist under present conditions but of the possibility of lowerin the cost of manures, probably by measures securing cheaper tra port, and of popularizing the use of such fertilizers as cakes and f manures (and especially the latter), and, by creating a steady dema for indigenous products, helping to stem the flow of such commodit as oilseeds from this country. It is not within my province to sugge how the present unsatisfactory state of affairs with regard to expo of oilseeds can be altered, but, as is well known, the protectiv tariff in France and Italy against foreign oils at present makes i

economically unsound to crush seeds in India; nevertheless the fact remains that this country is exporting valuable nitrogen and getting only a byproduct price for it, whereas the oilcake, if retained in India, would be invaluable to agriculture, being, as has been shown in numerous localities and for a great variety of soils and crops, the soundest nitrogenous manure obtainable. It seems certain that co-operative credit will enable the cultivator to use manures more freely in the near future; it is our duty therefore to provide reliable information as to how to use them and to make such arrangements as are possible to supply them at the lowest possible cost.

I have taken up so much of your time in considering the necessity of manuring that I cannot make any pretence of dealing adequately with the subject of providing manures whether nitrogenous or otherwise. The whole question requires and demands immediate and exhaustive inquiry at the hands of the Agricultural Department. Can we use hydro-electric power economically in India for the production of combined nitrogen, and can this compete with imported products such as Chilean nitrates, nitrolim and calcium cyanamide? Can we divert the stream of organic nitrogen which flows out of India in the form of oilseeds, bones and hides so as to use the by-products as a source of this element? Can we extend the production of saltpetre so as to make better use of this valuable method of recovering nitrogen which otherwise is lost to agriculture? Can we recover as fish manure any considerable portion of the nitrogen which goes by rivers, streams and sewers into lakes and into the sea, and can we by any means increase our soil stock of nitrogen by the popularization of sounder methods of crop rotation with legumes and of green-manuring?

So far as phosphates are concerned there can be no doubt that India would benefit enormously by the greater use of such natural supplies as can be obtained from Christmas Island and perhaps Egypt or even in Bihar. But here again commerce and agriculture must be brought together to their mutual benefit by the wise guidance of the Agricultural Department so that the uninstructed cultivator may not suffer disappointment as a result of undue commercial enterprise, and on the other hand the merchant's

chance may not be prejudiced by want of proper information. In this connection it is worthy of remark that by reason of the high average temperature of the soil and the proportionate intensity of bacterial action therein, this country is probably in a position to utilize large quantities of raw phosphates in conjunction with green-manuring without the expensive intervention of sulphuric acid. This point again requires and demands the earnest attention of the Agricultural Department.

The most important point in this enquiry is one to which I would now draw your attention with a view to obtaining your several and collective opinions thereon. It appears to me that the following principles are involved in the question of whether India as an agricultural country can afford to buy manures :—

(1) A country which is farming on old soils cannot compete with one utilizing virgin soils so long as the latter is recklessly willing to pay dividend out of the capital reserves of plant food in those soils.

(2) A country possessing limited mineral wealth and only insignificant industrial resources cannot compete agriculturally on even terms with a country which owing to its possession of such resources can afford to pay for the manures necessary for intensive cultivation.

These remarks need qualification in respect of special crops such as rice, jute, cotton, and tea for which correspondingly special conditions of climate and soil are required, but the case of these crops emphasizes the necessity of considering the possibilities of competition between India and such countries as America and Canada so far as wheat growing is concerned. Again then we come to the question whether India can afford to adopt the policy of raising crop production above the level fixed by Nature and adopted by the Indian cultivator. In my humble opinion this can be done to a certain extent by making the best use of the natural resources of the country, but it is to be considered whether India can at present afford to use high yielding varieties of crops and intensive cultivation since she cannot at present afford to pay the

ork's market price for imported manures such as would be required
prevent depreciation of her soils under such conditions.

The improvement of agriculture in India from the point of
iew of utilization of manure is entirely a question of economics
quiring a very wide view and extensive knowledge for successful
olution. Can the country as a whole go on exporting nitrogen,
hosphates, and potash indefinitely without sooner or later becoming
ankrupt agriculturally ? Can indeed the rural districts supply food
the urban centres with their rapidly growing populations ? The
ld condition of affairs in which, owing to lack of facilities for
ommunication and transport, a district was self-supporting, is being
placed by one in which increase in such facilities is leading to
eavy exports of foodstuffs from the fertile areas and even to the
placement of food crops by revenue-producing crops such as
ite and cotton. Measures must therefore be taken to ensure
hat the transport facilities which are giving rise to this condition
f impoverishment of our soils shall be fully utilized to convey
anures from such centres as can provide them to the districts
here they can be profitably employed as the raw material for crop
roduction ; no method of Government control can prevent the
ultivator from substituting revenue crops for food crops, but
overnment can perhaps so influence the general situation by helping
o lower the cost of manures and so allowing of the full utilization
f the crop-producing powers of our agricultural machine—the
nproved plant—as to make revenue crops include rather than
xclude the food-producing classes.

The original questions, then, may be answered as follows :-

(1) India does require nitrogenous fertilizers but she also requires a supply, *pari passu*, of other soil constituents without which in many, nay in most, cases nitrogen will do more harm than good.

(2) India cannot afford to pay for imported nitrogenous fertilizers at the same rate as other countries whose mineral wealth and local consumption gives them an economic advantage, but on the other hand there are possibilities in this country of making better use

than at present of indigenous supplies of nitrogen. At the same time it would be fatal to divorce consideration of nitrogen supplies from that of other manurial constituents, so that the question resolves itself into whether India can afford to adopt the policy of raising *and keeping up* the general fertility of her soil, that is to say of taking up intensive farming rather than continuing the indigenous method of keeping the crop yield down to the level to which it is naturally restricted by the continued normal rates of nitrogen fixation and mineral disintegration. One thing is certain and that is that it must be wrong to devote most of our energies and attention to the provision of high yielding varieties of crops and to intensive methods of cultivation without first making adequate provision against the depletion of the soil which will certainly follow their unrestricted use.

NITROGEN FIXATION IN INDIAN SOILS.

BY

C. M. HUTCHINSON, B.A.,

Imperial Agricultural Bacteriologist.

At the recent meeting of Agricultural Chemists held at usa, a resolution was passed drawing attention to the importance f investigations concerning the biology of Indian soils and the ecessity of creating posts of soil bacteriology in all the Provincial gricultural Laboratories to carry them out. This expression of pinion by the meeting was based upon recognition of the very umerous problems connecting soil fertility and soil biology, but f all these the conditions determining the fixation of atmospheric itrogen in the soil must, I think, be considered of paramount nportance. This subject has had but little attention from soil iologists up to now, mainly because although undoubted additions f nitrogen take place in the soils of countries with temperate limates, as has been shown at Rothamsted and elsewhere, yet the mount thus added is relatively small in cultivated soils, partly ecause of the comparatively low organic matter content of such oils as a consequence of intensive cultivation and partly, and robably mainly, because the low temperature of such soils limits he rate of the beneficial action responsible for fixation and so eeps down the amount thus added to comparatively insignificant roportions. Now in India we have, as I have pointed out elsewhere, relatively high temperatures in soil and correspondingly high ates of bacterial action, so that any results from such activity ill be correspondingly great. This has been shown to be so in he case of ammonification and of nitrification, and we have indeed n connection with nitrogen fixation itself an undoubted proof of

the relative rapidity with which this occurs in Indian soils in the short growing period of legumes in our tropical and sub-tropical districts. This rapid growth, a direct consequence of the high temperature of soil and air, is accompanied by a correspondingly rapid fixation of nitrogen by the root nodule organisms living in symbiosis with these plants; thus in a growing period of six weeks a crop of *Crotalaria juncea* will fix as much nitrogen as a crop of clover in England in as many months, and similarly in eight weeks' time nitrification of a full dose of oilcake will be completed in Pusa soil, whereas in England this might take anything from four to eight months. In the case of symbiotic nitrogen fixation, moreover, we are limited to the growing period of our leguminous crops, a very short one when we consider that part of the time only during which active bacterial action is going on in the nodules; in non-symbiotic fixation such as that effected by azotobacter and various clostridial forms so far as we know at present there is no such limited period, nor is intensive cultivation generally practised in India with the consequent rapid reduction in the organic content of the soil which apparently in England is responsible for limiting this kind of bacterial action. In a very large number of Indian soils, however, we find a natural low content of organic matter, and also a very general prevalence of drought over considerable periods of the year, resulting in a reduction of the moisture content of the soil below that favourable to bacterial activity; these unfavourable conditions might therefore be considered to reduce the importance of asymbiotic nitrogen fixation as a serious source of soil nitrogen in this country, and to relegate this question to the same relatively insignificant position in India as it has occupied in the past in countries with temperate climates. Observations made at Pusa of the rate of fixations of nitrogen both in field soils and in the laboratory have confirmed my opinion that not only is the amount of nitrogen taken from the air and added to the soil by azotobacter of considerable economic importance, but that this amount may vary within such wide limits that it seems highly probable that, were we in possession of more accurate information as to the causes of such variation, we should be able to increase this amount very considerably

ite possibly by mere soil management such as is made use of secure nitrification, or possibly by the addition of some stimulating bstance which may be absent in some soils. The accepted theory present assumes the rate and amount of nitrogen fixed to be termined or at least limited by the carbohydrate content of the dium in which the organism is acting. In Pusa soil in the field addition of sucrose in varying quantities was followed by proortionate increase in the amounts of nitrogen fixed; this amounted some cases to several thousand pounds per acre per annum, t the cost of the sugar was relatively high and precluded its use an economic measure. Similar results have been obtained the use of molasses in sugar-growing countries such as Mauritius, t here again the cost of the application was out of proportion the value of the result. Conclusions based only on the assumpn that nitrogen fixation is limited by the artificial addition of nparatively expensive carbohydrate materials would therefore pear to be unfavourable to the theory that such a source of soil rogen is likely to be of economic importance, but I have for some ars been of opinion that the wide variations above referred to as urring in Indian soils must have their origin in some other cause an mere differences in the carbohydrate content of the soil. In Indian soils which I have examined, algæ are found, fulfilling eir natural function of adding to the organic matter content of soil by taking the necessary carbon from the CO_2 of the air. have only to assume a symbiotic relationship between such en algæ and nitrogen fixers such as azotobacter, the one supplying bon and the other nitrogen, both drawn from the air, this symbioaction consequently enriching the soil and not depleting it, d we can then understand how nitrogen fixation can proceed, ited only by the necessary soil moisture and the presence of such rganic salts as are requisite for the growth of these organisms. has yet to be discovered whether the variations observed in the ounts of nitrogen fixed in various soils are due to imperfections this symbiotic relationship, resulting perhaps from the association inappropriate strains or species of algæ or of azotobacter, or the sence of appropriate amounts of some limiting soil constituent.

Alternatively it might be found that the total annual fixation depends upon the coincidence of appropriate weather conditions with seasonal variations in the activity of one or both of the symbiotic organisms. Control of this factor would probably then depend again upon soil management with reference to moisture and possibly aeration, and as azotobacter is found at considerable depths in some soils the former is the more probable source of variation.

One very probably important factor in fixation of nitrogen in soils, as it has been shown to be by Golding in artificial culture, is the continuous and concurrent removal of the products of the bacterial action involved in the process of fixation. As in many other natural processes accumulation of certain products appears to interfere with their continued formation; in the case of fixation of nitrogen as the result of symbiosis between radicicola organisms and leguminous plants, the latter appear to remove from the root-nodule such products of the physiological functions of the former as might hinder continuation of this process. There is reason to believe, as the result of recent work in this laboratory shortly to be published, that the nitrogen fixed by azotobacter in the soil is after its fixation at any rate partly present in the latter in the soil water. Accumulation of this nitrogenous organic matter in the near neighbourhood of the organisms responsible for its formation may very well interfere with their further action either by limiting reproduction or metabolic activity or both. This accumulation would be prevented to some extent by movements of soil water and it is very probable that this factor in the environmental conditions so far as the activity of azotobacter is concerned, may be found of prime importance. The apparent reduction in rate of fixation in soil under crops, may be due to competition between the latter and the nitrogen fixing organisms for such soil constituents as available phosphates, potash, or lime, which may be in defect in various soils and any enquiry into this subject must necessarily take account of this possibility.

Recent work in the Punjab carried out by the Agriculturist Chemist to the Government of the province, has conclusively demonstrated the practical importance of this question and the

ressing need for further work on the subject. Mr. Wilsdon, and r. Barkat Ali, his Bacteriological Assistant, have found nitrogen cation in certain Punjab soils amounting to an addition of as much .30 per cent. to the nitrogen content of the soil during the year, d this in soils under wheat containing only comparatively small uantities of organic matter. The enquiry is still at an early stage d the conditions determining this astonishing rate of fixation are t yet known, but it is clear that this is an outstanding case of e kind I have referred to above where some apparently insignificant use has been responsible for what must amount to an enormously tent factor in maintaining the fertility of the soil. It is evident at could this determining factor be discovered, in all probability should be in possession of a means of drawing, without undue penditure of energy or of money, upon the inexhaustible supply nitrogen in the air, and so avoiding the depletion of this soil nstituent which is so likely to occur as a result of the adoption of ensive methods of cropping and cultivation now in vogue. For s reason amongst others I would call attention to the prime essity of appointing soil biologists to carry out work on this ally important problem in every part of India; were no other logical problems of importance to agriculture known to require idation, this one alone would justify the expenditure necessary secure its adequate investigation.

Note.—The results obtained in the Punjab have not yet been published, but the following ct from a recent letter received from Mr. Wilsdon by the writer will be of interest:—
"Determinations were made of the fluctuations of total nitrogen in various Punjab soils g the fallow of a wheat after wheat rotation. In 1916 extraordinary amounts were fixed, verage for all the soils examined being as much as 58 mgm. per 100 grams of soil. The st fixation was 104 mgm. in Lyallpur soil. The determinations were repeated again in at Lyallpur only, and no increase was detected. In 1918 arrangements were made to d the work over all the chief districts of the province. In most soils the nitrogen remained ant or fell, but in some, fixations of 30, 20, and 16 mgm. were observed."
Here, as Mr. Wilsdon points out, the chief interest lies not only in the quantities of nitrogen but in their variation in amount from year to year, thus inevitably suggesting the existence unknown factor which it must be our business to determine and if possible control. Harrison in Madras and Mr. Warth in Burma have found evidence of similar important ons of air nitrogen to rice soils under swamp cultivation.

THE TRUE SPHERE OF CENTRAL CO-OPERATIVE BANKS.

BY

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IN July last an article entitled the "True Sphere of Central Co-operative Banks" by Mr. R. B. Ewbank was published in the *Agricultural Journal of India* (Vol. III, Pt. III). To this Mr. N. B. Kelkar, Governor of the Central Provinces and Berar Co-operative Federation, has recently (Vol. XIV, Pt. I) made a reply, to which I propose to add a few words on behalf of the central banks of Bihar and Orissa.

I should like to start by subscribing to Mr. Ewbank's main theory that our object should be to build up healthy independent primary societies and that everything must give way to this object. I agree that in so far as the present system tends to concentrate all power and discretion in the central bank, in so far the central bank becomes "the seat of responsibility, the checker of applications" of individual members of societies, "the granter of credit," it is an evil, though it may in some circumstances be a necessary evil. On the other hand, I venture to disagree with him and even it may be, though I am not quite sure of his meaning, with Mr. Wolff, with the former on both theory and fact and the latter on theory only.

To take the theory first. I see no reason why a central banking union should not combine propaganda, organization, and inspection with its banking business. Mr. Ewbank says, "The true function of a central bank is simply to say 'yes' or 'no' to loan

applications and when it says 'no' to explain why, in order that a society may know in what way its credit is defective . . . Their true sphere is finance and not administration and control." In the words of Mr. Wolff, "The central bank is, when all has been got shipshape, to serve, not to be tutor to, the local banks. It is in fact designed to be a 'bank.' In Europe I prefer that it should be a joint stock company. Its manager's proper business is that of bankers qualified to meet commercial bankers on their own ground and form a link between the co-operative and the banking world." Now it seems to me first of all that there is some confusion of thought in all this. Is the central bank being condemned because it combines banking with propaganda, organization, and inspection, or because it dominates the societies too much? If it is the former, I am prepared to join issue merely as a pure question of theory. Suppose you have your "pure" bank which does nothing but say "yes" or "no," how does it get its knowledge to enable it to discriminate? Apparently from the reports of the union and the audit notes. If it does no inspection it must rely on these and become a mere machine to register the unions' orders, as the Mandalay Central Bank registers those of the Registrar. Then to all intents and purposes it is the union that is doing the banking, only it keeps a separate issue department, as it were. Why should not the two things be combined? It is merely a matter of organization, and the advantages of combination are obvious. A banker cannot have too intimate a knowledge of his client's business. The more he knows the safer he is, and the better it is in the long run for his client. Even the idea that it is wrong for a banker to take the initiative in starting new ventures is out of date. The Germans embarked on this business and with such success that, had they not been in such a hurry, they were about to conquer the world by it. Every other country is now copying the good points of their system. If this intimate connection between banker and client works in industrial and commercial banking, where the interests of client and banker are to this extent opposed that the banker thinks primarily of himself and his capitalist shareholders, then surely it will work doubly well in a series of linked co-operative

institutions where the interests of client and banker are identical. Therefore I say that theoretically I can see no objection to a central bank conducting propaganda, and founding and inspecting societies, but rather the reverse. In practice, we have the good reason (which Mr. Ewbank recognizes) for the combination that we have so few competent workers that we *must* combine. There is therefore no need to argue the matter.

But I do believe and always have believed that the more inspection can be decentralized the better. We have found in Bihar and Orissa by experience that one central bank cannot finance and manage more than 100 to 150 societies with success without some intermediate link. This we hope we have found in the guarantee union, but some organization there must be outside the societies themselves which can act as guide, philosopher and friend to the primary societies. Too much centralization and domination is undoubtedly bad—and it is a fault into which a federation or a guarantee union can fall just as easily as a central bank—but with our societies in Bihar and Orissa a strong hand from without is absolutely necessary at the present stage. The description which I once wrote of our societies, which Mr. Crosthwaite quoted in his excellent book[1], will show how essential this is. These societies probably form a great contrast with most of the societies Mr. Ewbank knows in Bombay, and this accounts to a great extent for his different point of view. What *we* require is a benevolent despot anxious to train his subjects to early home rule—in fact what the Government in India claims to be and its critics say it is not. In my experience, as many central banks fail from acting the part of King Log as from playing the more energetic rôle of King Stork.

So much for theory, and it is when we get to fact that I have more complaints to make. Mr. Ewbank's picture of the activities of a central bank may be true of some provinces, but it is certainly not true of Bihar and Orissa. Our central banks have nothing whatever to do with audit, except to see that defects pointed out in audit

[1] "Co-operative Studies in the Central Provinces and Berar," by H. R. Crosthwaite, C.I.E.

otes are remedied. Up till now the auditors have been appointed nd paid by Government. Our new federation will shortly take ver their pay and appointment, but it is a federation of primary ocieties and not of central banks; while the Registrar is *ex-officio* overnor and appoints and controls all the auditors. None of the ocieties, so far as I can remember (though it is possible that there re one or two exceptions), are now required to deposit their re-erve funds in central banks, although most of them have been ersuaded to invest part of them in Government paper. In so far s they are at the mercy of central banks, they at least can, in most ases, if they wish, themselves direct the policy of the central bank. he following statement shows the number of individual members nd societies in each of our central banks and unions and the amount f share capital paid up by each class :—

rial o.	Name of central society	Date of establishment	Number of members		Share capital paid up			Remarks
			Individuals	Societies	By individuals	By societies	Total	
					Rs.	Rs	Rs.	
1	Provincial Bank	16-3-14	17	27	20,000	86,000	106,000	In 14 out of 22 central banks the societies have already acquired a controlling interest.
2	Bihar C. B.	8-11-11	..	77	5,830	4,884	10,714	
3	Barh C. B.	30-9-13	59	72	6,840	9,924	16,764	
4	Gaya C. B.	6-6-13	60	61	9,480	4,610	14,090	
5	Nawada C. B.	14-6-10	76	180	10,000	9,660	19,660	
6	Jehanabad C. B.	13-10-13	57	122	8,050	9,368	17,418	
7	Aurangabad C. B	19-11-14	88	69	2,400	2,596	4,996	
8	Muzaffarpur C. B.	24-5-13	80	67	9,950	5,220	15,170	
9	Siwan C. B.	21-2-15	51	84	7,550	6,052	13,602	
10	Gopalganj C. B.	22-3-17	50	29	2,440	1,112	3,552	
11	Rohika Union	21-12-09	13	56		11,776	11,776	
12	Daulatpur C. B.	13-6-14	22	84	32,475	6,034	38,509	
13	Bhagalpur C. B.	12-5-13	112	28	9,620	1,370	10,990	
14	Madhipura C. B.	2-9-11	95	57	16,170	11,082	27,252	
15	Supaul C. B.	30-5-14	64	42	7,220	2,766	9,986	
16	Banka C. B.	5-10-15	13	40	960	690	1,650	
17	Purnea C. B.	17-3-14	67	40	8,710	2,488	11,198	
18	Ranchi C. B.	10-6-10	63	155	3,628	3,820	7,448	
19	Banki Union	26-3-10	...	80	...	21,270	21,270	
20	Jajpur C. B.	30-10-14	53	48	6,250	1,804	8,054	
21	Khurda C. B.	22-3-12	45	62	3,598	8,502	12,100	
22	Balasore C. B.	19-2-16	14	37	1,240	2,438	3,678	
23	Kendrapara C. B.	29-5-18	Newly formed.					
24	Cuttack C. B	9-5-18						
25	Bettiah C. B.	12-7-18						

Except in the case of the provincial bank, each member and ach society has only one vote whatever shares may be held, nd it is therefore only a few years in each area before the societies

have the real power, if they can learn to use it. Already they are beginning to make their weight felt in some areas and it will not be long before this tendency will greatly develop.

As for the assessment of credit, central banks do not assess the credit of individual members. This is fixed at the annual general meeting of the primary society under the presidency of a director of the central bank, the manager or, if it exists, a representative of the guarantee union. Without such guidance, in most of our societies such meetings would be a farce, for the simple reason that only one or perhaps two of the members can read and write, and these members, even if capable of conducting a general meeting according to rule, inevitably tend consciously or unconsciously to abuse their position of vantage. The results of these meetings, duly communicated to the central bank, enable it to fix a credit for the society as a whole and to see that no individual member transgresses the limit imposed without recourse to a special general meeting.

Mr. Wolff's objection that a central bank's proper business is to form a link with the commercial world hardly applies in India, where this link is found in the provincial bank, which provides professional banking experience and joins up the societies of the province with the money market. To Mr. Willoughby I would say that he has obviously got the wrong type of men as directors. What we find in Bihar is that the best directorate is a mixture of town dwellers and small landholders resident on their estates. Wherever the latter can be secured, our central banks do excellent work. Where they are not forthcoming, as is usually the case in central banks situated at the headquarters of districts, central banks fail—but from doing too little and not from doing too much—and the Registrar may have to replace them by banking unions of the pure type, or to arrange to finance groups of guarantee unions direct from the provincial bank.

The gist of my reply to Mr. Ewbank is, therefore, that I dispute his theory that it is wrong to combine co-operative banking with propaganda, organization, and inspection, and that so far as Bihar and Orissa is concerned some of his facts are not correct. All the same he has done us all a service in bringing prominently before the public

danger against which constant warnings have been sounded in our ovince. If central banks, guarantee unions, or federations ntralize, more than is absolutely necessary, either finance or ntrol, the peasants of India, always ready to rely on Government sistance, will never learn to think for themselves and to manage eir own affairs. They must have advice and control, but *in their n villages* and not at headquarters, and this advice and control ust take the form of making them themselves decide their own licy, whether in respect of new members, or personal credit or at not. If they do this under guidance, in time they will learn do it themselves; otherwise co-operation will never rise above e level of a semi-official *takavi*.

SECTIONAL MEETINGS OF THE BOARD OF AGRICULTURE IN INDIA.

I. THE THIRD ENTOMOLOGICAL MEETING.

THE Third Entomological Meeting was held at Pusa from 3r to 15th February, 1919, and was attended by upwards of fif delegates interested in the various aspects of entomological wor in India. Besides the Pusa staff of the Entomological Sectio the Agricultural Departments were represented by delegates fro Assam, Bengal, Bihar and Orissa, the United Provinces, the Nort West Frontier Province, Bombay, the Central Provinces, and Madra as well as from Hyderabad, Baroda, Central India, Patiala, Myso and Travancore. The Forest Department and the Indian Te Association also sent representatives in the persons of Mr. C. Beeso Forest Zoologist, and Mr. E. A. Andrews, Entomologist to th Indian Tea Association, whilst Captain Froilano de Mello attende as a delegate from Portuguese India. This was also the first o these Sectional Meetings to attract visitors from outside of Indi the Egyptian Government sending an official delegate in Dr. Lew H. Gough, Director of the Entomological Service in Egypt, an Mr. R. Senior-White attending from Ceylon.

The proceedings were opened by Mr. J. Mackenna, C.I.E., I.C.S. Agricultural Adviser to the Government of India, in a short speec in which he welcomed the visitors to the meeting and dwelt on th importance of the development of entomological work in India The Chairman, Mr. T. Bainbrigge Fletcher, Imperial Entomologis then delivered an opening address, in which he welcomed to th meeting the many delegates from India, Ceylon, and Egypt, an explained that this meeting partook of a more formal character than the preceding ones held in 1915 and 1917, inasmuch as th scheme of holding such meetings had recently been regularized

by the Tenth Board of Agriculture in a resolution approved by Government, and that one effect of such formality would be the appointment of committees to report on particular questions and the adoption of resolutions in cases where a subject was of sufficient importance and there was a clear preponderance of considered opinion regarding it. A tribute was also paid to the memory of the late E. J. Woodhouse and C. W. Mason, two former co-workers in Indian entomology, whose deaths have occurred since the last meeting, and a formal resolution expressive of this was put before the meeting and passed in silence, all standing. The Chairman next called attention to the suggestions made from more than one direction that an Entomological Society might be formed in India, and asked the meeting for a collective opinion on the subject of the treatment to be accorded to German workers and German entomological literature in the future, and emphasized the need for some restrictions in the output of entomological literature both as regards the numbers of periodicals and the languages in which publication should be permissible. Dealing with the war in connection with entomology, he showed how the adoption of scientific methods, amongst which entomological research must be included, have reduced to a comparatively trifling proportion the preventible losses due to insect-borne diseases, and the enormous losses still due to insects in connection with military stores and foodstuffs. After pointing out how insects have anticipated the most recent developments of the "camouflage" principle and other so-called modern inventions, such as the process of paper-making from wood-pulp, he touched lightly on the subject of the control of crop-pests and pointed out the importance of an accumulation of exact records of occurrence to enable outbreaks of pests to be forecasted in the future, and then briefly reviewed the programme before the meeting.

The programme, which comprised ninety-two papers, was divided into twelve sections, each paper being read either in whole or in part or in abstract and being then open to discussion by the meeting as a whole.

The First Section was devoted to Agricultural Entomology, in which subject no less than thirty-seven papers were offered.

In a short note it is obviously impossible to mention all of the even by name. The first paper taken, on the control of insect pests by Mr. E. A. Andrews, was not, as its title apparently indicated, a general treatise on pest control, but dealt with certain problems which were found to arise in connection with the control of particular insect pests of tea in North-East India, and emphasized that effective methods of control cannot be devised unless accompanied by a thorough acquaintance, not only with the life-history of the insect, but with its relation to the plant attacked in all circumstances, and of the behaviour of the plant under different methods of cultivation and the nature of its response to environmental conditions and to modifications of existing agricultural practices. In another paper Mr. Andrews also described the recent work done on *Helopeltis theivora*, the "Tea-mosquito" of Assam, whilst Dr. T. Shiraki of the Agricultural Experiment Station at Taihoku in Formosa sent a paper on insect pests of the tea plant in Formosa, many of these being identical with those found in India.

The backbone of the meeting was provided by an annotated list of general crop-pests, by Mr. T. Bainbrigge Fletcher, this comprising a list in systematic order of all insects known or reasonably suspected to cause damage to cultivated plants in India, with a short summary of our present knowledge of each insect. Specimens of the various insects had been got together beforehand in cabinet drawers, which were handed around the meeting so that all might see the insects concerned, and as each insect was brought forward the delegates were invited to add any further information regarding it, many of the papers on particular insects being taken during the discussion on these crop-pests.

The insect pests of cotton were dealt with in several papers. Messrs. Bainbrigge Fletcher and Misra gave a short account of the experiments carried out at Pusa to test the relative immunity of different varieties of cotton to attack by bollworms. Dr. Lewis H. Gough, Director of the Egyptian Entomological Service, gave a most interesting account, illustrated by lantern slides, of the work done in Egypt against *Platyedra gossypiella*, the Pink Bollworm, which was introduced into Egypt from India a few years ago and

; sing e proved a very serious pest. Mr. F. G. Willcocks, Entomo-ist to the Sultanic Agricultural Society in Egypt, also sent a very eresting paper on experiments on the survival of resting-stage rvæ of the Pink Bollworm in ripe damaged cotton bolls buried different depths. Attacked bolls were buried at various depths bare fallow land and in land cultivated with wheat and bersîm l, even in cases where a crop of bersîm had been grown and gated and finally cut, larvæ were found to have survived in the ried bolls. An experiment of this sort shows how easily these nk Bollworm larvæ may be carried over from year to year in fallen ls in cotton-fields in India.

Cane-borers formed the subject of a special paper, by Messrs. Bainbrigge Fletcher and C. C. Ghosh, in which all available ormation was summarized and the distinctions between the various ers pointed out.

Fruit-pests were dealt with in the list of general crop-pests and e information was also summarized by Mr. C. S. Misra in a list the various fruit-trees with the pests of each. Mr. D. T. Fullaway it a paper on the control of the Melon-fly in Hawaii by a parasite roduced from India; this parasite (*Opius fletcheri*) was collected Bangalore by Mr. Fullaway, who successfully introduced it into nolulu, with the result that the infestation of cucurbits by fruit-s has now been reduced by fifty per cent.

Although not strictly insects, crabs formed the subject for two pers, by Messrs. C. C. Ghosh and K. D. Shroff, on crabs principally their rôle as pests of the rice-plant, and the discussion on these pers elicited several facts of considerable interest.

Section II was devoted to Forest Entomology, on which r. C. Beeson, Forest Zoologist, read a very interesting paper on me problems in forest insect control, in which he dealt with e work being done on certain insects.

Section IV dealt with Household and Store Pests and included o papers, by Messrs. T. Bainbrigge Fletcher and C. C. Ghosh, the preservation of timber against termites and on stored grain sts. The former dealt with the experiments with various pre-rations tested at Pusa during the last eight years, the results

attained corroborating those obtained at Dehra Dun by Mr. Pearson. The latter gave an account of the Pusa experiments on grain storage, and it was shown that grains stored under a layer of sand remained practically immune from attack by insect pests. Mr. K. Kunhi Kannan contributed a note on the insecticidal property of mercury, in which he stated that in Mysore it is the custom to store a little mercury with grains to avert insect attack and that experiments showed that the mercury prevented pests from breeding and so acted as a protection, although its exact manner of acting was not yet understood. Mr. Ram Rao S. Kasergode read a paper on the methods of storing potatoes to prevent insect attack and gave a description of the methods found effective at Poona.

Subject V, Bee-keeping, comprised a paper on bee-keeping in India, by Mr. C. C. Ghosh. Dr. Gough also gave an account of the methods of bee-keeping in Egypt and particularly of the enemies of bees there and of the methods adopted against them. A discussion on the means of improvement of bee-keeping in India led to the passing of a resolution that, in view of the danger of the introduction into India of bee-diseases by the unrestricted importation of bees, beeswax and honey, such importation should only be permitted under necessary restrictions.

Subject VI, Lac, included a paper on lac-culture in India by Mr. C. S. Misra, and Subject VII, Silk, included several papers on sericulture. Mr. M. N. De gave a short account of the Pusa experiments on the improvement of mulberry silkworms, and also a paper on the best method of eliminating pebrine from multivoltine silkworm races. The subject of pebrine was also dealt with by Mr. C. M. Hutchinson, Imperial Agricultural Bacteriologist, who gave a most illuminating lantern-lecture on his researches on pebrine. At the general meeting the subject of pebrine gave rise to an animated discussion which was undoubtedly of benefit to all concerned. In this section also Mr. C. M. Inglis gave an exhibition of specimens and drawings of Indian wild silkmoths, while Mr. J. Henry Watson sent a note on the life-history of *Caligula cachara*.

Subject VIII dealt with Life-histories and Bionomics, on which enty-one papers were communicated. Major F. C. Fraser, I.M.S., hibited a large series of drawings showing the early stages of dian butterflies, many of which have not been described hitherto: a paper on night-flying dragonflies he also called attention to the t that some species of dragonflies fly naturally only in the evening d that most of these species are of considerable economic impor- nce as feeding largely on mosquitos. In a paper on the forms of *pilio polytes*, Professor E. B. Poulton, F.R.S., called attention the interesting field in research offered by this butterfly with its ree very distinct forms of female, of which two forms mimic otected swallow-tails. Mr. E. A. d'Abreu gave a summarized count of his investigations on the insect prey of birds in the ntral Provinces, another subject on which very little is on record India. The subject of rearing of insects was dealt with by ssrs. Bainbrigge Fletcher and Ghosh, who gave an account of methods used at Pusa, and by Mr. C. Beeson, who described breeding cages and general insectary technique used for ring wood-boring insects at Dehra Dun, and these papers re supplemented by a description by Mr. Andrews of the rear- methods adopted at the Tocklai Experimental Station. The ier papers in this section dealt mainly with life-histories of Indian ects.

Subject IX dealt with the Collection and Preservation of Insect ecimens with especial reference to India, and in a long paper on is subject Mr. Bainbrigge Fletcher gave a series of hints based on enty years' experience of collecting insects in hot climates. E. H. Hankin exhibited specimens of specially prepared glass xes for preserving insect specimens, and Dr. D. Sharp, F.R.S., ntributed a note on the importance of collecting.

Subject X, Systematic Entomology, included eleven papers, which we have only space to refer to a few. Mr. E. Meyrick, R.S., contributed a sketch of our present knowledge of Indian crolepidoptera, a subject on which he has been working for past fifteen years, and in a lantern-lecture Captain Froilano de llo gave an account of some Trichonymphid parasites of Indian

termites. The question of the desirability and practicability of t preparation and publication of a general catalogue of all descrit Indian insects formed the subject of report by a committee, wh report was approved by the meeting in a resolution endorsing t desirability of this and appointing a standing committee to ta the necessary steps to carry out this project.

Subject XI dealt with Publications, the first item taken bei a note by Mr. C. Beeson on the decimal method of indexing ent mological literature. This led to a discussion which culminat in a resolution concerning the desirability of the adoption of standard classification of entomological literature for India. In paper on suggestions regarding publication of communications Indian insects, Mr. C. C. Ghosh recommended the establishment of Entomological Journal for India and after considerable discussi this suggestion was endorsed by a resolution passed by a majori of the meeting, but another resolution postponed any action in th matter being undertaken for the present. A paper describing t methods to be used in preparation and those employed in reprodu tion of scientific illustration-work was contributed by Mr. A. Slater, Manager of the Calcutta Phototype Company, and illustrat with figures showing the effect of correct and incorrect preparati of illustrations.

Subject XII, Miscellaneous, included any items not includ in any of the other sections. In a note on plant imports, M Bainbrigge Fletcher described the legislative restrictions on t importation of plants into India imposed by Act II of 1914 and t actual methods employed in working this Act. A general discussio on entomological education in Provincial Agricultural Colleges wa initiated in a committee formed of all those engaged in teaching work of this kind, and a report drawn up by this committee wa approved by a resolution of the general meeting, to the effect tha all Agricultural Colleges should make provision for the teaching o entomology, and that the teaching should be of a practical nature. A paper by Mr. C. C. Ghosh on some aspects of economic entomolog in India, in which he drew attention to the facility with whic entomological subjects could be used for the teaching of Natur

tudy, led to the passing of a resolution suggesting that entomology hould figure prominently in all courses of Nature study, that primary chool readers should contain simply written accounts of common ocal insects, and that the help of entomological workers should e enlisted in the preparation of such accounts in readers or text-ooks. The subject of the organization of entomological work in ndia was considered by a committee which drew up a report hich, after consideration of Appendix K to the Indian Industrial ommission's Report, affirmed the desirability of the centralization f entomological research work in India, but considered that the imensions of the proposed entomological service are not large nough and that provincial staffs will be required in addition o the staff of the Central Institute. As regards the employ-ent of these provincial staffs, whether under the local depart-nental authorities or directly under the Entomological Institute, here was considerable difference of opinion and there were also lifferences of opinion regarding the most suitable location of the Entomological Institute, but as these differences were clearly hown in the report of the committee on this subject, the report as approved unanimously by the general meeting after consider-ble discussion.

The meeting concluded by various speeches which elicited e speakers' views that these meetings are of very real value o the various entomological workers scattered throughout India nd that, of all those held so far, this third meeting has been the ost successful. Indeed, if imitation be truly the sincerest form of attery, the entomologists may congratulate themselves on having iven a lead to other workers in the matter of these sectional meetings.

A full report of the proceedings of this meeting is now in reparation and will be issued in due course.

II. THE SECOND MYCOLOGICAL MEETING.

THE Second Mycological Meeting was held at Pusa from 20th o 24th February and was attended by official representatives rom the Agricultural Departments in the different provinces and

Native States, the Forest Research Institute, Dehra Dun, and the mycological staff of the Agricultural Research Institute, Pusa. In addition to these the meeting had the advantage of the presence of Capt. Froilano de Mello, Director of the Bacteriological Laboratory, Nova Goa, Portuguese India, and of Mr. A. C. Tunstall Mycologist to the Indian Tea Association.

The meeting was opened by Mr. J. Mackenna, C.I.E., I.C.S., Agricultural Adviser to the Government of India. In his opening speech Mr. Mackenna extended a hearty welcome to all visitors to the meeting and said that mycology was a branch of agricultural science which was still something of a mystery to the cultivator and the general public. However, there were now many cheap and effective remedies against fungal diseases of which the success and popularity of the steeping of *jowar* (*A. Sorghum*) seed with copper sulphate, as a preventive against smut, was a striking example. Since the last meeting an event of considerable importance to mycologists had been the publication of Dr. Butler's book on "Fungi and Disease in Plants.".

In introducing the subjects for discussion Dr. Butler said that the Second Mycological Meeting was being held under a somewhat more definite constitution than on the last occasion, since the policy of holding sectional meetings, advocated at the last meeting of the Board of Agriculture, had been accepted by the Government of India. He thought that the attention of the present meeting should be directed to the more important mycological problems in India and, in view of the present economic crisis in the world's food-supply, that they should concentrate as far as possible on the major diseases of food crops and the means of combating their ravages.

In this connection he would like to call attention to the work of the War Emergency Board of American Plant Pathologists. This body was formed a little over a year ago with the object of stimulating and accelerating phytopathological work in America, to the end that, in this present world crisis, the reduction of crop losses from diseases should be made most effective as a factor in the increase of our food supply. Of the extent of those losses the

llowing figures compiled by the Board for the United States alone 1917 gave some indication :—

Wheat	64,440,000	bushels.
Rye	2,685,000	,,
Barley	12,252,000	,,
Oats	153,973,000	,,
Maize	175,344,000	,,
Total cereal loss	408,694,000	,,
Potatoes	117,174,000	,,
Beans	2,528,000	,,
Sweet potatoes	41,707,000	,,

And this was in a year which was not an especially bad one as r as diseases were concerned. These estimates had been most refully framed and were said to be the most reliable that had ever en made. Had oat smut been completely controlled (and they knew that it could be so controlled), the amount of this cereal ported to the allies and neutral nations could have been almost ubled, while twice as usual maize was lost from smut as was ported. In India the losses due to plant disease were at least ual to those recorded elsewhere. Thus in Bombay Presidency one the losses from smut of *jowar* were estimated at one million erling annually—a loss which it was quite feasible to control.

At the conclusion of Dr. Butler's speech the meeting passed a olution expressing its gratitude at the generous offer of assistance eived from the War Emergency Board and welcoming the portunity of co-operating in mycological work with the scientists an allied nation.

The meeting then proceeded to the discussion of Subject I—survey of the diseases of plants in the different provinces. ider this head it was decided to consider, one after another, the jor crops and their fungal diseases.

The storage rots of potato first occupied the attention of the eting. The importance of a proper method of storage was isted upon by many speakers. The experience of the military thorities in India, and the shortage of potatoes in Germany ring the first year of the war, alike illustrated the essential charac- of this point. In India a private firm in Poona had set up an icient system of sorting, fumigating and packing seed potatoes

for Mesopotamia, a work in which they had been greatly helped by the mycological staff at Poona.

There was some discussion on the incidence of ring disease, scab and other fungal troubles of the potato and the meeting then passed on to the consideration of diseases of cereals.

Among cereal diseases one of the most important for India was smut of *jowar*. This disease could be completely controlled by seed steeping in a solution of copper sulphate and a great deal of time and energy was being expended by the Departments of Agriculture in Madras, Bombay, and the Central Provinces in spreading this treatment among the cultivators. In Bombay about 40,000–50,000 one-anna-packets of copper sulphate were sold annually. In fact, as one member of the Bombay Agricultural Department expressed it, "the district agricultural officers go out into the countryside to spread the gospel of agricultural improvement bearing an iron plough in one hand and a packet of copper sulphate in the other." The rust and smut diseases of wheat caused a considerable amount of loss in all parts of India and the introduction of resistant varieties of wheat was evidently one of the most promising lines of work. A variety of Australian wheat called Federation had been introduced at Peshawar and was found very resistant to both smut and rust. The varieties Pusa 4 and Pusa 12 were also resistant to rust, although the former was susceptible to smut in Peshawar. It was evident that the problem of rust-resistance in wheat was one which varied in different localities. For a country the size of India it did not appear likely that wheats bred in any one centre would be resistant to rust throughout the whole continent.

The most important Indian cereal—paddy—was fortunately very free from serious fungal diseases. An epidemic of "blast" had occurred locally in Madras during one season but had not re-appeared since.

The meeting next discussed diseases of sugarcane. The most important disease was red rot. In Madras a method of stool selection had given excellent results and had reduced the infection to 1 per cent. On Pusa Farm only set selection had been practised and by this method the disease could not be reduced below 10 per cent.

rut of sugarcane, although a disease of minor importance, was of reat scientific interest as the method of infection had just been iscovered at Pusa.

Other crops which were discussed were gram, chillies, cotton, te and others. In the case of the wilt disease of gram and pigeon a the results now being obtained from the permanent manurial periments on Pusa Farm were of great interest. It was becoming parent that the incidence of wilt in pigeon pea was considerably fluenced by the manurial treatment. Chilli diseases were very mmon in Bihar and experiments at Pusa had shown that a great al to control them could be done by spraying.

The first day's session terminated at the conclusion of this scussion on the major crop diseases.

At the second session the meeting discussed Subject II, the oposal to form an Imperial Bureau of Mycology in England with ecial reference to the directions in which the Bureau might be eful to colonial and Indian mycologists. During this discussion was evident that all members of the meeting were in agreement to the very real need for such an institution. Previous to the tbreak of war, mycologists in India and the colonies had been gely dependent upon foreign countries for assistance in certain nches of their work. This assistance had in the case of enemy ntries been cut off during the last four years and it was now possible to resume the old relations. It was agreed that the ties of the new Bureau should be :—

(1) to organize a system for the prompt identification of all injurious fungi for Departments of Agriculture and other similar bodies;

(2) to publish a periodical for summarizing current literature on plant diseases, British and foreign;

(3) to prepare and keep up-to-date classified lists of references to the past and present literature of the subject, and to establish a library;

(4) to answer enquiries from plant pathologists.

The meeting was also in favour of the laboratories of the Impe- l Bureau of Mycology being open to such colonial and Indian

mycologists as were desirous of carrying out mycological researc during their periods of leave. At the same time the meeting emphasized the importance of research work in colonial and tropic phytopathology being done on the spot, and held that it would not be desirable for the Imperial Bureau of Mycology to engage directly in research work, other than work of systematic nature, o tropical diseases. At the conclusion of this discussion Mr. Mackenz asked that in view of the importance of the subject a copy of th minutes might be forwarded to him for submission to the Govern ment of India.

The meeting next considered Subject III, the spraying of crops Interesting accounts of the spraying of tea in Assam, vines i Bombay, areca palm in Madras and Mysore, and fruit orchards i Peshawar and Kumaon were given to the meeting by the member interested in the subject. From a financial point of view th spraying of vines in Bombay Presidency was perhaps the mos successful instance. Spraying had in this case made the vineyard a certain source of large profit to the owner, whereas it had formerly been a risky speculation. All who had had experience of spraying in India during the last few years agreed that the difficulty in obtaining sprayers and their high prices had been limiting factors in the extension of spraying. The successful manufacture of sprayers in Mysore was a matter of great importance and it was generally regretted that these sprayers were not yet open to purchase by the public.

The formal session on the second day terminated at this point and the members spent the remainder of the day in the mycological laboratory examining specimens and seeing such research work as was in progress. In the evening Capt. Froilano de Mello delivered a lecture on Medical Mycosis. Captain de Mello's account of human diseases of fungal origin opened up a new, and fascinating, branch of mycology to most members of the meeting. An excellent series of lantern slides illustrated the lecture and the fortunate discovery by Capt. de Mello that several members of the menial staff possessed on their persons, excellent examples of dermatomycosis enabled him to give a demonstration in laboratory technique.

The third session opened with the discussion of Subject IV—seases of planters' crops.

In discussing the organization of mycological research for anting industries the meeting considered the system in vogue in e Federated Malay States where a large plantation was run as an perimental station and the profits were utilized towards scientific search. In the Federated Malay States such experimental stations elded a profit which nearly met the cost of the local Agricultural partment. The meeting generally agreed that this system was cellent, provided that there was no attempt on the part of Govern-nt to subordinate the research interest to profit making.

After a detailed consideration of the various diseases of coffee, , and rubber, the meeting proceeded to discuss Subject V—myco-ical education in provincial colleges.

The representative of each province in turn gave the meeting brief account of the standard of mycological education in his ovincial Agricultural College.

Apart from the official courses in mycology in the Agricultural lleges an interesting new departure was the attempt to establish nycological class for "estate writers" at Coimbatore. The object s to train Indians from rubber estates to carry out plant patho-ical observations and plant sanitation on the plantations where y were employed. These courses had been running for two years l were very successful. After training, the men were placed in arge of "pest gangs" on the estate and were responsible for erations against fungal diseases. The vernacular course in sugar-e culture and the course in arboriculture at Poona, were other tances of this type of instruction.

The meeting was greatly interested in an exhibit of models of nt diseases which were used in the courses at Coimbatore. These dels, which were superior to anything imported from Europe, e made locally and there was a general desire that arrangements ght be made so that such models could be purchased by other leges.

The lack of mycological education in Indian Universities was erally regretted by the meeting. It was considered that

such education as existed was of a type which attached too mu importance to a mere book knowledge of European types and la too little stress on the necessity for a knowledge of Indian fungi.

The last matter discussed was Subject VI—the applicati of genetics to the control of plant disease. The meeti considered that this subject was one which offered peculiar scop for development in India. It was pointed out that in Euro the efforts of generations of nurserymen engaged in breeding ne varieties of plants for commercial profit had resulted in the more, less unconscious selection of disease-resistant races. Thus the was a relatively restricted field for the scientist. In India, however the crops had not been the object of improvement by nurserymen and therefore more rapid results might be expected than could b obtained in highly civilized countries. Wheats which were mor or less resistant to rust had already been bred at Pusa and a ver resistant Australian wheat had been introduced at Peshawar. Th meeting agreed that, while the application of genetics to th control of plant disease was a matter at present scarcely develope in India, each member should note during the next two years any direction in which it appeared that this method could b utilized and should bring up the case for discussion at the nex meeting.

This concluded the formal proceedings of the meeting. A small committee sat later to consider diseases of rubber and in the evening Mr. Kulkarni gave a lantern lecture of the type which he was in the habit of delivering to cultivators in Bombay. Mr. Kulkarni explained how he kept the attention of his audience by enlivening the details of fungal diseases with lantern slides showing scenes from Europe, pictures of cattle, steam ploughs, etc., which would be likely to interest the ryots.

The proceedings terminated with an informal meeting in the Mycological Section, on 24th February, for the discussion of matters of laboratory technique and an exhibition of spraying machinery.

A detailed report of the proceedings will be issued in due course.

III. THE FIRST CHEMICAL MEETING.

THE first meeting of Agricultural Chemists and Bacteriologists
i India was held at Pusa from the 24th to 28th February, 1919,
nder the chairmanship of Dr. W. H. Harrison, Imperial Agricultural
hemist. It was attended by the Agricultural Chemists of all
ovinces, and also by Mr. W. A. Davis, Indigo Research Chemist,
r. C. M. Hutchinson, Imperial Agricultural Bacteriologist, and
r. R. D. Anstead, Deputy Director for Planting Districts, Madras.
ie meeting was opened by Mr. J. Mackenna, C.I.E., I.C.S.,
gricultural Adviser to the Government of India, who welcomed the
legates and emphasized the value of such meetings in relation to
e future development of the investigation of Indian agricultural
oblems.

There were ten subjects down for discussion. These may be
adly stated as follows:—

(1) References from the Government of India.

(2) Consideration of facilities for the development of industrial problems arising out of the successful researches of Agricultural Chemists and the provision of specialized laboratories for the investigation of problems of general importance.

(3) Questions regarding the Service of Agricultural Chemists, their duties, and the technique of their work.

(4) Post-graduate teaching in agricultural chemistry at Pusa.

(5) Bacteriological subjects.

It will be remembered that the Board of Agriculture in India,
ts meeting held at Poona in 1917, passed a resolution that in its
ion the time had arrived when some form of legislation was neces-
to regulate the sale of fertilizers in India in order to protect
the planting industries and the Indian cultivator. The Govern-
t of India requested the meeting to frame a draft Fertilizer
applicable to Indian conditions. This was accordingly done,
Fertilizer and Feeding Stuffs Act in force in the United Kingdom
g taken as a model and suitable modifications made therein.
other reference from Government for detailed consideration was
olution VIII of the same Board dealing with the question

of reducing the present railway freight for the carriage of manur To any one acquainted with conditions in this country, the impo tance of increasing the use of concentrated manures as a part of t general agricultural development of the country is obvious. Amo the causes which operate against the extended use of the manu is the fact that manures have to be carried over long distances fr the centres of supply to make them available to cultivators. Fu ther, the demand of the individual cultivator is mainly for sm consignments of manure, and in view of the caste prejudices prevale in the country many fertilizers, such as bone-meal, dried blo and poudrette, are classed by the railway companies as offensi goods. Again, there is no uniformity in the rates charged at prese by the various railways for the carriage of manures. After a d consideration of the various difficulties it was resolved that t Railway Board be asked to arrange that the present minimum ra of 1/10th pie per maund per mile should be charged in all cases, minimum waggon loads of such concentrated manures, and that t Provincial Agricultural Departments should encourage the formati of local distribution centres so as to build up a regulated traffic whi is capable of taking full advantage of the concession of the minimu rate.

It very often happens that the research work of an Agricultu Chemist or Bacteriologist leads up to a problem of industrial impo tance which he is obliged to give up because there is no suitabl technological laboratory for carrying it to a successful commerci issue. The work done on malt extracts in the Coimbatore laborator and on saltpetre, indigo, etc., at Pusa, are instances in point. Th creation of a technological laboratory as one of the special sections o the Imperial Agricultural Department under the Government o India where such subjects of industrial importance can be carri to a successful commercial issue was therefore recommended by th meeting.

There are again numerous problems which though not directl industrial are still of great importance in connection with agricultur Among such problems requiring immediate consideration are (1) animal nutrition, (2) soil physics, and (3) vegetable biologica

hemistry, but there are neither specialized laboratories nor suitable taffs to undertake this work. The meeting recognized the need or the provision of such laboratories with separate staffs under the Government of India for the investigation of such problems of general application. It was felt that the location of these laboratories should be determined by the particular requirements, as egards, for instance, the need for collaboration of their staffs with ther departments, sections, climatic and other conditions and hey need not necessarily be at Pusa.

The proposal made in the Report of the Indian Industrial Commission for the formation of a Chemists' Service was not accepted y the meeting mainly because intense local knowledge is required or effective work for agricultural improvement by chemical methods, nd it is not desirable that the Chemists in the Agricultural Departments should be formed into a Service apart from the Indian Agricultural Service, in which the bond of union would be the Science rather han its application. On the other hand the meeting was definitely f the opinion that in addition to the Agricultural Chemists attached o the Provincial Departments a strong central body of chemists hould be maintained by the Imperial Department of Agriculture rom whom Provincial Departments can draw for the investigation f special problems.

With the rapid expansion of chemical investigations in the provinces it has become necessary to relieve the Agricultural Chemists f the teaching work so that they may be enabled to devote more of heir time to research work. The meeting, therefore, recommended uplication of the chemical staff for the adequate pursuit of research nd teaching. In the opinion of the meeting the duties of the Agricultural Chemist as opposed to the Professor of Chemistry should be primarily limited to the research and executive side only, giving such assistance in teaching as may arise out of his research and which fits in with the college course. The teaching officers should also be given opportunities to engage in research work.

The meeting next considered the question of soil surveys. It held that soil surveys throughout this country would be of undoubted value not only in cases where new lands are in question but

also for general application as a means of obtaining information as to the relationships between climate, soil, and crop. The necessity of standardization of methods not only in the case of such surveys but also in the analysis of soils and other materials was recognized and important recommendations were made.

The question of post-graduate teaching in agricultural chemistry at Pusa and the class of student to be admitted to this advanced course was then considered. It was resolved that the teaching should be strictly directed to instruction in the various specialized branches of agricultural chemistry and that the students to be admitted to this course should be either graduates of an Agricultural College, or Science graduates of an University who have attended a Provincial Agricultural College for at least a year and are recommended for further training in agricultural chemistry by the Agricultural Chemist.

A day was specially set apart for the consideration of bacteriological subjects. The necessity of providing for the proper study of soil bacteriology by the Agricultural Departments in India was recognized, a full discussion of provincial conditions having revealed an urgent demand for the investigation of bacteriological problems either connected with the soil or with agricultural industries. It was accordingly recommended that Local Governments should consider the desirability of adding an Agricultural Bacteriologist to their scientific staff.

The question of the standardization of methods of biological analysis of soils was also considered in detail.

Detailed proceedings of the meeting will be published in due course.

"WATER SAVING" EXPERIMENTS.

BY

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THE main factors chiefly affecting the yield of crops per acre e the amounts of water, labour and manure put into the land. heoretically, the farmer's problem everywhere is to use that amount water, labour and manure per acre, and to use them in the way hich will produce him the greatest profit per acre. But, practically, ving to their varying availability and cost, the relative importance these several factors in crop production varies enormously from lace to place, and it is rarely that all are simultaneously of great nportance. The amount of water used is only of importance here the supply is limited and controllable. This is the case in rigation farming in a dry climate. Here in reckoning profit per ere we must consider not only the rental value of the land, and the ost in labour and manure, but also the water-cost of the crop. When the climate is very dry and the water-supply is strictly mited or very expensive, then the water-cost becomes the item f greatest importance on the debit side of the balance-sheet. uch circumstances exist in parts of Northern India, the west of orth America, and in many other countries. The object of the resent paper is to indicate the lines on which the study of the ater-cost of crop production should be taken up in India. The eed for this work is obvious to everyone conversant with agri- ultural matters in Northern India, and was recognized by the oard of Agriculture at its 1917 meeting.

The factors affecting water-cost.

The water-cost of producing a certain weight of any crop per acre depends on some matters practically beyond the control of the farmer, such as the climate and the mechanical composition of his soil. But it also depends on the following matters which are to some extent within his control :—

(1) The irrigation given: not only the total amount of water used for the crop, but also the depth and frequency of the waterings at different stages in the growth of the crop.

(2) The richness of the soil in available plant food.

(3) The physical condition or tilth of the soil at the time of sowing.

Both of these (2 and 3) depend on the rotation which has been followed, and the manure and cultivation given.

(4) The way in which the water is applied—whether by flooding the whole field or applying it only in furrows; the size of *kiaris*,* etc.

(5) The extent, and frequency, etc., of subsequent cultivation by harrowing or interculture.

(6) The botanical variety of the crop selected for sowing.

(7) The seed rate or number of plants per acre.

Our present knowledge.

Some work bearing directly on this matter of water-cost of crops has been carried out in Europe and India; but very much more has been done in America by a considerable band of workers—King, Widstoe, Briggs, Fortier and many others. The American work has received curiously little attention in India, possibly because the results have only recently been mentioned in text-books. Naturally the American results are not quantitatively applicable to India; in fact, even qualitatively, they need some amplification and confirmation for Indian conditions. But enough has been done in America to show that no field of investigation in

* Compartments used in the Indian method of irrigation.

ndia is likely to repay study more quickly or fully. And enough as been done to indicate the relative importance of the factors hich have been outlined above. The American work has shown hat the order of importance of these factors, in regard to the degree o which they affect water-cost, is the order in which they are iven above, and that the former three are of vastly greater im- ortance than the latter four. In the present paper attention is iven to the first three factors only, because they are most important, heir consideration logically forms a basis for future work, and hese three factors are all intimately connected, and must be studied ogether.

The irrigation given.

roblem 1. *The relation between frequency of irrigation and the stage of growth of the crop.*

It is frequently stated that zemindars are in the habit of over- rigating their crops. Experience in the Punjab leads the writer o believe that this is frequently not true in regard to the critical eriods when the needs of the crop are greatest. But there is a istinct tendency among zemindars, both on wells and canals, to rigate with approximate uniformity throughout the life of the op. Yet the water requirements of plants are known to be very ifferent at different stages, the transpiration rate at its greatest eing often ten or even twenty times more than at the beginning r end of the period of growth. Thus it is possible that the irriga- on can be greatly reduced at certain stages, with little or even no fect on the final yield. To put the water so saved to useful purpose ay not always be easy where there are no reservoirs,[1] and this in rn will need to be considered. (It is probably the difficulties i this respect which have deterred zemindars from paying more ttention to such saving.)

Conversely it is possible that yields might be increased by ore irrigation than is now sometimes given during the critical me when the need is greatest.

[1] Roberts, W. and Faulkner, O. T. "Some factors affecting the efficiency in the use of ial water." *Agric. Journal of India*, Special Science Congress Number, 1918, p. 81.

Instances of these possibilities in the Punjab may be cited in regard to the wheat and cotton crops. Our experience and experiments at Lyallpur show that the needs of the wheat crop for water are very much greater during a period of six or eight weeks than during the remainder of the time the crop is on the ground. There is still much room for investigation even on this point; but, roughly, the period when the need for water is greatest is from about the time of the "shooting" to that of the "yellowing" of the stalk. That is generally from some time in early February till late in March. Thus experiments carried out some years ago at Lyallpur,[1] and repeated experience since then, have shown that, in case of fields which have previously received at all adequate irrigation, a watering in April, such as is frequently given by zemindars, does not increase the yield of the crop. Again, wherever heavy wheat crops have been grown with very little irrigation, as in our experiments at Lyallpur, the figure for quantity of water applied has been reduced by withholding irrigation except during the period referred to.

Similarly, in the case of cotton in the Punjab, it is evident that the crop can grow with much less water during its early life in May, June and at least the early part of July, than it needs during a period of some eight weeks from late July till about the end of September or early October. All that can be said at present is that good crops have been obtained in spite of greatly reduced irrigation during the earlier growth of the plant. But again the relation, on different soils, between the irrigation given at different stages and the final yield, awaits and merits investigation.

For if, as appears to be the case, the needs of the cotton-fields for water are much less during the hot weather than during the monsoon months, then larger areas of this crop can be sown with prospects of success if there is a fair monsoon. But if the monsoon fails, and the maintenance of a comparatively high water content in the soil during these months is as important as appears to be possible, then it might conceivably pay to concentrate the

[1] *Experiments, etc., at the Agricultural Station, Lyallpur, Punjab.*

available water on the best fields, in spite of the failure of the worst.

This matter has also an important bearing on the design of inundation canals, and on the question, which has recently been raised, as to the advantages of high *kharif* (summer) supply capacity on perennial canals.[1]

Problem 2. *The best depth of water to apply at one time under varying conditions of soil, season and crop.*

The ideas of zemindars on this subject are not at all definite; in the main, their practice seems to be usually to apply as little as possible at once; but the actual amount varies very greatly and depends chiefly on the condition of the soil at the time of watering, and the rate of the water-supply. A little consideration will show that a simple answer to this question cannot be given off-hand. When irrigation water is applied to a dry soil, it quickly percolates to a certain depth, which will be of the order of about one foot per inch of water applied. After this it only moves down more slowly and in lesser quantity. The rate will always vary according to the texture of the soil. Obviously to reduce the losses in this direction to a minimum, the irrigation should be as light as possible. A uniform moisture content is the ideal condition for the growth of plants: this will be more nearly attained by giving frequent small irrigations. But on the other hand the loss by evaporation from a recently irrigated soil is known to be very rapid in a hot climate—much more rapid, for instance, than the evaporation from a still water surface. It is possible that this loss may at times be equivalent to more than one inch of water in the first three days after irrigation.[2] Evidently there is a possibility of considerable economy from heavier and less frequent irrigations. The best amount to apply will thus be that quantity which effects the best possible compromise. This amount will depend on the time of the year, the presence or absence of a crop, the stage of growth of the crop, and, of course, on the

[1] Roberts, W. "Extension of American cotton in the Punjab." *Report of the Punjab Engineering Congress*, 1918, p. 1.

[2] *U. S. A. Office of Experiment Stations Bull.* No. 248, p. 14.

nature of the soil. American experiments give us little assistan in this respect, and we must find out the best depth of waterin for ourselves.

But it is not enough to know only what is the best amou to apply: it will often be equally desirable to be able to form son idea of the loss that will result from applying more or less tha this amount. For at times when water is available in exces it may well pay to incur some loss through excessively heavy ir gation, in order to delay the necessity for the next irrigation. On case where this might apply in the Punjab, in some years, is in th *roni** irrigation for early sown *toria* (*Brassica campestris*). Agai wheat-fields in the Punjab frequently do not require irrigation, afte sowing, until February; but it might pay to give heavy watering to some fields in January in order to allow of a delay in the nex (February) watering. In some years it may pay to give heavy ro waterings in the early wheat-fields, in order to ensure that the fir watering after sowing (*cor*) will not be needed until all sowing is ove Frequently, on account of attack by white ants, the early sow wheat-fields have to be watered again in November or early Decem ber, which interferes with sowings.

Problem 3. *The relation between total irrigation and yield.*

This is a question of the greatest importance not only to farme but also to Government in its control of rivers, canals, and reservoi and it is the problem in irrigation which has received most attenti in America: this is practically the only fundamental problem irrigation farming in India which has received any attenti experimentally. In the Punjab some useful and systematic fie experiments were carried out by the Canal Department.[1] The experiments only dealt with the wheat crop. From the farmers' poi of view, these experiments are less useful than from the engineer For before the yields of the different plots in such experimen can be exactly applicable to farming practice, it is evident th the different amounts of water compared must each be distribute

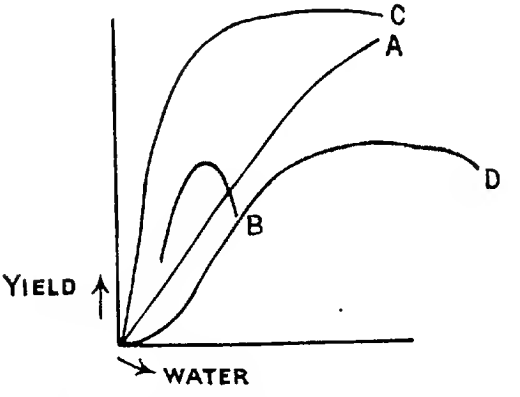
* *The watering given just before sowing.*

[1] *Punjab Irrigation Branch Papers*, 1904–08, pt. III.

ugh-ut the life of the crop in the best way practicable. Of no one has yet been in a position to judge.

In order to explain the prevailing ideas on this subject we may with the wheat crop which has been most studied from this t of view, and must, for the present, express the total quantity ater applied to the crop in the very crude form of "number waterings including that just before sowing," and neglect fall which may replace part of the irrigation.

The zemindars' idea seems to be that, within any reasonable s and if properly applied, "the more water the more yield," that the shape of the curve is something like the line A on the ram.



Mr. A. Howard [1] apparently considers that the shape of the e is like the line B, with the maximum at about two waterings with a fall immediately beyond this point, due to lack of soil tion as a result of excessive watering. The only experiments ifying this conclusion seem to be those near Buchiana which the following results :—

	Gungapur	*Haripur*
One watering	12¼ mds.*	8¾ mds.
Two waterings	18 ..	15½ ..
Three waterings	14¾ ..	16¼ ..

* 1 maund=82 lb.

[1] Howard, A. "Recent investigations on soil aeration, with special reference to agricul-" *Agric. Journal of India*, vol. XIII, pt. III, p. 426.

Now the first experiment was carried out on good soil, yi the highest yield is only 18 maunds. In the same year, on lan which is not better than that used in these experiments, we ha yields of 30 maunds in spite of applying no less than four waterings. It would thus appear that the low yield obtained from three waterings is not entirely due to an excessive number of waterings. General considerations of the processes of plant growth in soils, the numerous experiments on this point in America, the experiments at Lyallpur and many observations on well and canal lands, the experiments conducted by the Punjab Irrigation Department, all these indicate that the shape of the curve is something like the lines C and D in the diagram. At first, as the quantity is increased, the yield rises rapidly to a certain point. In the case of wheat grown on average well cultivated land in the Punjab this point represents a production of at least 25 maunds of grain on a total water-supply of about 12 in., of which some is usually in the form of rain. On poor or ill-cultivated soils the maximum yield will be less and will need more water. The curve must therefore be something like the line C or D according as the field is good or poor. (See *also Problem 4 infra.*)

Beyond the maximum, the yield remains practically constant in spite of great increases in the irrigation. Presumably a point could be reached where the yield is decreased through some secondary factor due to over-watering. But the author has not seen any reliable results from field experiments definitely to support the statement in regard to the wheat crop. There is no doubt that the irrigation would have to be very heavy or very ill-advisedly applied to have this effect.

Problem 4. *The relation between the richness of the soil and the water-cost of crops grown on it.*

Problem 5. *The relation between the tilth of the soil and the water-cost of the crop grown on it.*

Roughly, the practice of zemindars is to irrigate all fields to much the same extent. Any deliberate distinctions drawn are on

ccount of differences in mechanical texture or on account of alkalinity
the soil—not because of differenees in amount of available plant
od or in tilth. Yet it can often be predicted that two neighbouring
elds will give enormously different yields simply on account of their
mporary fertility ; and it would seem possible that it might pay to
ve different total amounts of water to these fields. Yet it is probable
at as a rough and ready compromise the zemindars' practice
not far wrong. For on the one hand it would seem that the rich,
ell-cultivated field capable of giving a heavy crop will better
pay ample watering. But, on the other hand, it is well known
at the water-cost of the same weight of crop decreases within
ide limits as the plant food available in the soil increases ; so
at on this account the poorer field should receive more water.
ne effect of differences in tilth on the water-cost of the crop has
t been so exactly investigated, but there is no doubt that the
me statements hold good with regard to that too. These points
wever need thorough investigation, for they are of great practical
portance.

The experiments suggested.

The principles underlying the solution of these problems may
elucidated by pot experiments, studies of field moisture contents
d laboratory investigations. But in India we also need data
fficiently reliable, quantitatively, to justify exact and definite
ommendations to zemindars or to canal authorities. Such data
n only be obtained from very carefully conducted, practical,
d amply repeated plot experiments, in which water is given
the different plots in varying amount and with varying frequency.
is evident that such experiments will have to be repeated on soils
different mechanical composition. Sufficient elaboration in this
spect should not be impossible ; for observations indicate that
all differences in mechanical composition in soils do not cause
eat differences in the water-cost of crops grown on them. But
e experiments must be repeated on the same soil in very different
ates of tilth or temporary richness in plant food, and also with
rying content of organic matter. If the experiments are to be

conducted on practical lines, this means that they must be repeated on neighbouring fields cropped under systems of varying intensity and manurial treatment.

The question of intensity of cropping is of one of the greatest importance in irrigation, and must be shortly considered here.

Intensity of cropping.

Although the matter needs much more scientific investigation, yet anyone who studies irrigation farming in arid climates, must appreciate that fallowing and manuring are here, within rather wide limits, practically alternative methods of enriching the soil. This is everywhere recognized as being true to some extent; but it would seem to be true to a much more remarkable degree in such a climate as that of Northern India than in a more humid and cooler one. Maximum crops, even of quick-growing plants, like sugarcane, can be grown without manure, if the land has been fallow for a very long while. An extreme instance of this is the heavy crops of thick cane grown on the recently cleared land of the Lower Bari Doab Canal Colony in the Punjab. And it must be the comparatively low intensity of cropping (about 100 per cent.), and the thorough cultivation on the Lyallpur farm, which accounts, at least in part, for the frequent failure of manures there to give such results as might be expected.[1] On the other hand, though experiments in manuring combined with high intensity of cropping have only just been started, the effect of farmyard manures, and the residues of a leguminous crop, etc., can frequently be observed to have remarkable effects under such circumstances. This seems to be especially true in regard to *kharif* crops such as cotton and maize. There can be little doubt that by suitable rotations, combined with manuring, fallowing may be reduced to a minimum and the intensity raised to about 150 per cent. And, further, it would seem that, if high yields are to be obtained by manuring, a high intensity of cropping must be adopted. For it cannot be profitable to have

[1] "The value of phosphate manures in India and the possibility of their manufacture on a larger scale." *Pusa Agric. Res. Inst. Bull.* No. 81, p. 9.

ich unmanured land lying fallow, earning nothing, and possibly ıffering losses of its humus content through oxidation or denitri-cation. This fact is reflected to some extent in the practice of ıany Punjab zemindars, who concentrate their manure on a portion ı their lands, and crop this portion more intensively. On the ıher hand, under a high intensity it is difficult to retain good tilth ı the soil, for there is less time for cultivation and fallows are ıorter.

This matter of the efficiency of different intensities of cropping well worth extended investigation: its importance in connection ith canal construction and working is obvious.

A necessary corollary of higher intensity of cropping will almost rtainly be an increase in the areas of fodder crops, which will be ilized for increased cattle-rearing and possibly, in the future, r more dairying. Thus the necessary higher supply of manure ill be provided for, whilst the fodder crops will rotate with the ain crops and occupy the land in the intervals between them. s the fodder crops will be partly legumes, they will not greatly crease the strain on the supply of nitrogen in the soil, and they ould prevent any losses in water or humus, which may occur hen a rich soil is lying fallow.

The question of the most efficient cropping of irrigated lands pends on many considerations, some of which are outside the ope of this paper. But the water-cost of the produce from the fferent systems must be the first consideration on which others e based. The experiments suggested in this paper will provide e necessary data for the consideration of the economic and gineering, as well as the farmer's, aspect of these problems.

SCHOOL GARDENS.

BY

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"THE scheme of primary and secondary education for the average scholar should steadily, as trained teachers become available, be diverted to more practical ends, *e.g.*, by means of manual training, gardening, outdoor observation, practical teaching of geography, school excursions, organized tours of instruction, etc."—[*Resolution of the Government of India, 1913.*]

This extract from one of the most important State Papers of recent years points to an ideal which is still in the distant future, and the steps which are being taken to lead to it are, as yet, slow and halting. There were many school gardens in existence before the date of this pronouncement, and since that date successive conferences of agriculturists have given expression to the widely held view that Nature study should form a necessary part of the curriculum in rural schools and that a garden should be attached to schools as an aid to Nature study. Yet there has been, so far as I know, no organized effort to provide either teachers of Nature study or gardens. The Education Department in my own province and I believe elsewhere also, has been supine in the matter and local bodies and their officials in whose hands the initiative lies have not had their attention prominently called to it. Yet there are vast possibilities in Upper India where nearly every family has some connection with the soil, where village school teachers are nearly all drawn from the rural population, and where land in the vicinity of village schools can generally be easily obtained. In

In order to familiarize the public and local authorities with the object and to encourage the organization of school gardens as an essential factor in a true rural education that this article has been written.

Objects of the garden.

The objects of gardening in schools may be said to be—

(1) to beautify the surroundings of the school;
(2) to limit expenditure on school buildings;
(3) to introduce an agricultural atmosphere into the school;
(4) to interest parents, school committees and the public in the school as a village institution;
(5) to stimulate in the neighbourhood interest in new vegetables, crops and varieties and to introduce to the locality such as may be found suitable;
(6) to inculcate in boys' minds the dignity of labour and introduce them to the spirit of service for the community;
(7) to emphasize the importance to be attached to agriculture; and
(8) to provide examples for the teaching of geography, arithmetic, mensuration and kindred subjects and material for Nature study.

A few remarks may be made in explanation of these objects. take the first two objects together. A bare whitewashed or d-brick school on a bare maidan, such as is still frequently seen, is viously likely to be an excrescence on the life of the village rather an a village institution in which the residents can take pride and easure. There is no protection from the sun and hot winds of mmer, nor from the cold winds of winter except in the school self, and therefore a large building is required. With a well-grown rden, boys can sit outside in the sun or in the shade according to e time of year, and even in the rains under light sheds constructed r the purpose. There will then be no need of extension of school ildings to meet an increased attendance. All that is required a small but a substantial building where the school effects can be

suitably housed, and where charts, maps and pictures and objects for drawing lessons can be displayed on the walls and shelves, and which would be a nucleus in and round which the boys would be collected for work, play and drill.

With the expansion of primary education, which is now taking place in all provinces, large sums are being spent on extensive buildings for central schools. It is submitted that large buildings are not needed, that the money had far better be spent on enclosing and laying out of gardens and the construction of wells and teachers' quarters.

Thirdly, the central and all-absorbing interest of an Indian village home is agriculture: ploughing, sowing, weeding, manuring, watering and reaping of crops and the tending of cattle. It is these occupations with which the boy is familiar, and which will take up his time in future years. But in the school he is in another atmosphere altogether—an unreal atmosphere of books and papers and sums which have little and sometimes no connection at all with his home experiences. His work in school is in no way correlated with his life out of school. It cannot therefore arouse his intelligence, or be made interesting to him, and cannot therefore be an adequate preparation for his life's work. As an American writer says: "Any form of education, to be effective, must reflect the daily life and interests of the community in which it is employed." Hence the necessity for the introduction of an agricultural atmosphere.

Fourthly, working parents seldom believe in the utility of education for their sons, and this is particularly true of agriculturists who work with their hands. If they keep their sons at school as they seldom do, after the age at which they begin to be useful in the fields, it is with the idea that they may, by acquisition of knowledge, be able to secure some literate post and draw a cash salary, however small, to help the family budget. They do not conceive that a boy, who is destined to carry on the family occupation of agriculture, will get any benefit from schooling. On the contrary, they fear that he will acquire a distaste for agriculture and habits which will unfit him for hard physical work in the field

he best means, therefore, of making rural education popular is to terest the general body of villagers, who also comprise the parents the boys in the school, by showing that it is not antagonistic to riculture, but on the contrary tries to assist it. How it does , is shown in the next paragraph.

The *fifth object* is to stimulate in the locality interest in new getables, crops and varieties, and to introduce to the neighbourod those found most suitable. In practice what can be done is obtain from the Agricultural Department or elsewhere seeds new vegetables, crops and varieties, and to raise produce from em in the gardens. The work is similar to that undertaken by monstration farms, but it is not called demonstration, because ethods of cultivation may be faulty or the locality may not be vourable, and so the crop may not be successful, and there may be thing to demonstrate, but it is obvious that in many cases the new aple or variety will turn out well, and it will then be eagerly adopted the neighbourhood. In a vast country like this, where demonration farms maintained under the control of the Agricultural epartment must always be far apart, the small plots attached to hool gardens for demonstration purposes must surely be a most seful means of displaying new staples, varieties and methods, hile the use of school gardens for these purposes will go a very ng way to interest the people in the schools. The planting of itable trees is another matter of which the villagers know little nd they might learn much from a garden and nursery (*see* Plan) nducted under expert advice.

The *sixth* and *seventh objects* are closely connected. It is one f the principles of school gardens that except for the heavy work f ploughing where necessary, all the work of cultivation is undertaken by the boys themselves. Indian boys, like others, are interested the mysterious processes of Nature. They enjoy seeing plants row up as the result of the work of their hands, and they have aturally no prejudice against agriculture, but, if the atmosphere f a school is purely literary and the teachers, though originally illagers themselves, have been led, by the urban and purely literary tmosphere in which they have been trained, to despise manual

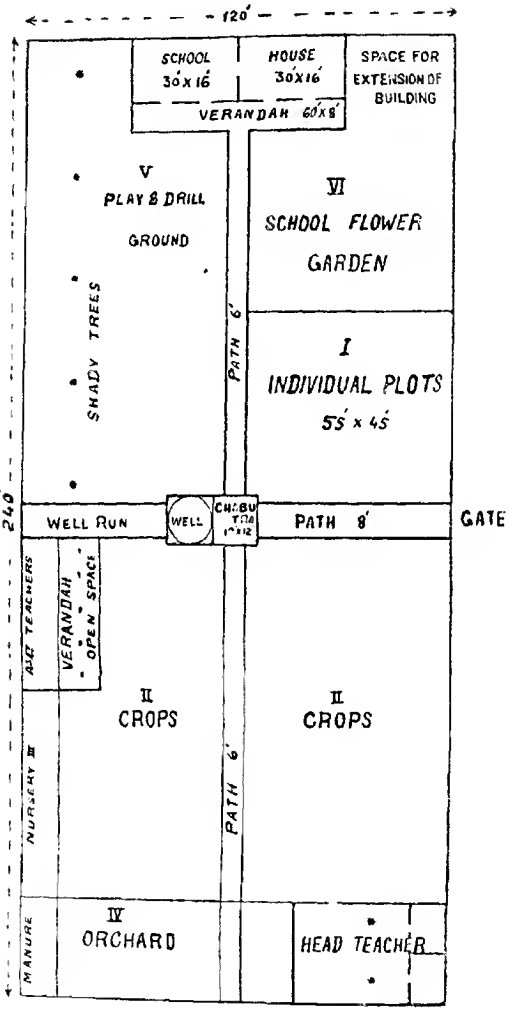
labour and depreciate agriculture, their ideas of gentility may be expected to infect their pupils, and an antidote is very necessary. In tending the gardens the boys also may learn how to co-operate with each other and, under the guidance of the teachers, to manage their own affairs, and may get their first lesson in the exercise of responsibility and in the duty of service to the community.

The *eighth object* is probably that which is most appreciated in western countries, though its utility is limited here by the paucity of teachers whose standard of training is sufficiently advanced to enable them to teach Nature study at all, or to make use of the garden in the teaching of other subjects; nor do the text-books at present in use give any assistance to the teacher in showing him how to utilize a school garden for the teaching of school subjects.

It was held at one time that object-lessons could take the place of Nature study, and that an inanimate object or even a picture of an animate object was a proper subject for study. Even now in Indian schools such lessons retain their place in the curriculum, and are defended on the ground that they cultivate a faculty of observation. but this theory has been put to the test and found wanting, and it is now almost universally acknowledged that the object-lesson should give place to Nature study which, in the words of a recent writer, "generates in the child a sympathetic interest in his natural surroundings—an interest which will ripen into the true spirit of scientific enquiry without losing the joyous impulsion of childhood." The recent Committee on Natural Science in England has adopted this view and recommended that Nature study should be taught in all rural elementary schools. At present in India Nature study as well as observation lessons are often included in the curriculum but cannot be generally taught as already stated, because the teachers have not been specially trained to teach them. It is generally regarded as non-essential in comparison with reading and writing, but since experience shows that most boys who leave the school at an early age after reading up to the Lower Primary standard, forget nearly all that they have learnt there, it would appear that Nature study, the effects of which are certainly lasting, would be of more educational value even than the three R's, and

PLAN OF SCHOOL GARDEN

(SCALE 40' = 1 INCH)



at special efforts should be made to train the teachers. Then school garden would indeed be essential.

The plan.

In order to form a school garden no great area of land is required. I annex a plan of one, the total area of which is 200 sq. yards, *i.e.*, two-thirds of an acre only.

The plan provides for a small school house, head teacher's quarters with enclosure, assistant teachers' bachelor quarters, and for a garden divided into six distinct portions as follows :-

First portion. A number of standard plots provided for each boy or pair of boys who want them and who are big enough to work them. These would be used chiefly for the growth of vegetables but partly also for flowers.

Second portion. A small field set apart for demonstration of new crops and improved strains of ordinary crops—wheat, rice, sugarcane, millet, groundnuts, etc.

Third portion. A nursery of young trees of different kinds to be planted out in the school compound or sold outside as required.

Fourth portion. A small orchard of fruit trees.

Fifth portion. A shady portion where school and drill can be held in the open air, sheds being erected if necessary, and where plants which do not mind shade can be grown.

Sixth portion. A small garden of flowers and flowering shrubs close up to the school.

The lay-out.

Having obtained the necessary land either round an existing school or having obtained a new site for the school, the first necessity is to build all round it a substantial brick wall 3 ft. high. This, at R. 1 per running foot, will cost some Rs. 720 and is no doubt an expensive item, but it is absolutely essential to have a wall, because no wire-fencing, ditch and bank, hedge or other enclosure will keep out goats, pigs, porcupines and other animals which do so much damage to a garden. A mud wall is as efficacious as a brick wall but requires constant repairs, and in the long run a solid brick wall is cheaper.

The land should then be measured and the different portions allotte on the ground.

The *first portion* (except possibly for the preliminary ploughing will be worked entirely by the boys themselves, and they will choos the seed and take the whole produce. Vegetables and flowers will ordinarily be grown as chosen by the boys. They would be well advised first to try the common vegetables and flowers and then if successful, those less well known in the locality. Among vegetables the following appear suitable :—Brinjals, sweet potatoes, radishes, carrots, beets, tomatoes, chillies, cauliflower, cow-peas, pumpkin and cucumber. The District Board will supply seed of good varieties from time to time. This portion should be divided into individual plots for one student or pair of students. These will vary in size according to the number of boys and amount of land available, but an ordinary size for one plot is 12 by 3 ft., and there should be a path $1\frac{1}{2}$ ft. wide between the plots.

The *second portion* should be worked so far as possible by the boys themselves. One of the teachers should keep an account of all the expenditure incurred, and after this has been paid off and sufficient seed has been retained for the succeeding year, the remainder should be distributed to the boys who assisted in the cultivation and irrigation. Seeds for the first year and for the varieties newly introduced should be supplied by the District Board without payment.

The *third portion*, a very small area, should, after the preliminary ploughing, be worked by the boys themselves in order that no expenditure be incurred. Zemindars and cultivators will be asked to supply seeds and plants of good kinds, and the District Board will also assist from time to time. The trees, as ready for planting out, will be planted in the school compound or sold or given away outside.

Fourth portion. This is intended for the demonstration of superior kinds of fruit trees to those ordinarily grown in the locality. They will be transplanted from the nursery as required.

Fifth portion. Some of the trees to be planted should be chosen for their shade-giving properties. There should be at

least two good shady trees—Bargad (*Ficus bengalensis*), Pipal (*Ficus religiosa*), Pakar (*Ficus Rumphii*) or tamarind. Other trees may be mango, Mohwa (*Bassia latifolia*), or Nim (*Melia*), all of which give fairly good shade.

Sixth portion. A garden close to the school. In the plan it is shown on one side of the central path. In it both flowers and flowering shrubs can be grown, and it should be worked by the boys themselves.

A well is of course a necessity unless canal irrigation is available. The cost varies so much in different localities that no estimate can be given.

Teachers' quarters. In order that the garden be properly tended, it is necessary that there should be some one living on the spot and this should preferably be the head teacher of the school. On other grounds too, it is desirable that he should be resident. The provision of decent family quarters adds to the comfort and self-respect of the teacher and makes him more contented with his lot and more interested in his school. Assistant teachers too generally live either, as they can, in some corner of the school house or at their homes some distance away; and in the latter case are frequently absent. It seems necessary that, unless they are actually residents of the village where the school is situated, they should live on the spot and only go home for week-ends. Accordingly for them also bachelor quarters are provided.

The head teacher's quarters, with enclosure, as in the plan, should cost about Rs. 100,0 and the assistant teachers' quarters about Rs. 430 each.

Conclusion.

Such is the kind of garden which I should like to see attached to all central schools. I recognize that the scheme is somewhat elaborate, that it requires the co-operation with the local authority of the educational, agricultural and horticultural authorities to bring it into effect, that it will further require, in order that the best use be made of the land, a special inspector or superintendent in each district. And more important than all, it will require the

whole-hearted support of one or more of the teachers in the school. A competent educationist indeed expressed to me his doubts, based on English experience, as to the possibility of doing anything useful through the agency of our present teachers, and feared that the only result of stimulating the laying out of gardens would usually be an untidy and neglected plot which would be an object-lesson of the worst type. He said that "it requires a teacher of exceptional qualities, physical and moral, to carry on a garden successfully." But circumstances are different in this country where school teachers are themselves villagers and brought up in an agricultural atmosphere. Experience in Allahabad, where portions of the scheme outlined above have been in force for several years past, show that many teachers are naturally keen on having a garden and only require guidance to make it a success, while the approval of inspecting officers, the competition between different schools for the best garden and an annual exhibition of produce provide sufficient stimulus for the large majority. And, indeed, if we are to wait till the perfect teacher arises before we take this first step towards introducing an agricultural atmosphere into our schools, we shall have to wait for generations.

DAIRY INDUSTRY AROUND COIMBATORE.

BY

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THERE are few places in the Madras Presidency which are more favourably situated than Coimbatore. It enjoys a very equable climate, neither too hot nor unpleasantly cold, with a steady western breeze blowing through a portion of the year. Geographically also it occupies a unique position. Situated in close proximity to the Nilgiri Hills, commanded by a railway, it affords facilities for any trade or industry that caters to the needs of the hills, unsurpassed by any other mofussil station in the south. It has a fairly large European population certainly larger than in the ordinary headquarters of a district—due to the official as well as commercial importance that it commands.

Agriculturally too, Coimbatore is important. Owing to the even distribution of the annual rainfall which in itself is only moderate, the farmers have facilities which their fellows in other districts have not. Even in dry lands they raise crops very early, as the light soils nearer the hills are ready for cultivation earlier than black soils which are more remote. In light soils they often raise two crops—a cereal, generally Cumbu (*Pennisetum typhoideum*), and a pulse—while in the heavy soil, the season being later, only one crop is possible. In the latter type of soil the usual rotation is Cholam (*Sorghum*), cotton, and Bengal gram (*Cicer arietinum*). Besides these, there are garden and wet lands. The former are commanded by wells, while for the latter the sources of irrigational supplies are river channels or tanks. The supply of water in the wells in garden lands is fairly steady throughout. The water is lifted by

means of mhotes drawn by bullocks which walk up and down a steep ramp. Three crops, two cereals, generally Cholam and Ragi (*Eleusine coracana*), and an industrial crop like tobacco, are raised. These are very intensively cultivated with heavy application of cattle manure.

In wet lands there is only one crop—paddy—though sugarcane is also cultivated in small patches. Green leaves for paddy and sheep penning for sugarcane are the recognized manures. It is obvious that whether it be for cultivation, irrigation, or manure, the garden land ryot is in continual demand for cattle.

With regard to cattle, Coimbatore is exceptionally privileged. Situated in the Kangayam country which is famous for its remarkably good breed of cattle, Coimbatore enjoys the enviable position of possessing one of the finest types of working cattle, both for mhote and draught purposes. It also draws on Kollegal grazing tracts for a large proportion of its working cattle. The cows of this breed (Plate IV, fig. 1), however, contrary to one's expectations, are but poor milkers and are maintained more for breeding purposes than for their performances at the pail.

The grazing grounds for cattle in the neighbourhood are not abundant. These are, however, available a few miles distant near the hills, where the hill tribes—Irulars—graze cattle for a nominal fee during the off season. Stall-feeding is a necessity, although there is a kind of grazing obtainable, throughout the year, on the tank bunds and roadsides, which carries with it all the evils which communal grazing entails. The bulky food consists of any available green fodder like *cholam* and *ragi* straw or green grass. For concentrated food, cotton seed is given twice daily along with some *cholam* water obtained by soaking the grains overnight. Cakes and bran are little known. When dry, the animals are put on a dry ration.

Cow keeping being unprofitable, the buffalo (Plate IV, fig. 2) is the mainstay of the dairy industry. Being an animal which thrives on rather coarse food such as that rejected by other live-stock, and one which can without prejudice be put to work in wet lands, when not milking, the milch buffalo is sought after especially on account

Fig. 1. A Kangayam cow.

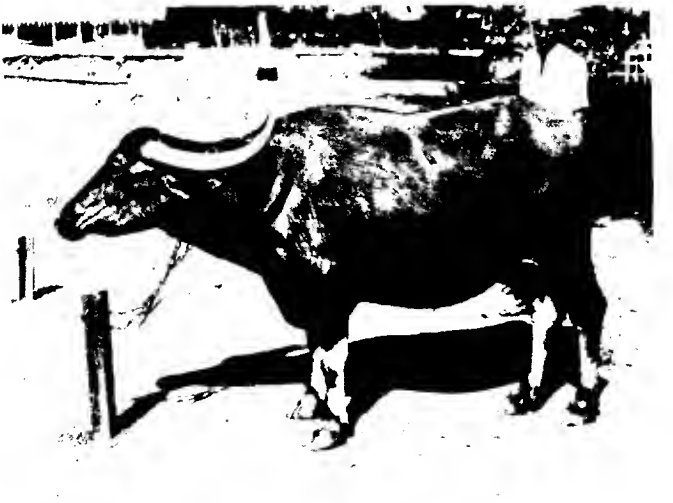


Fig. 2. A Coimbatore buffalo.

f the milk which is better both in quality and quantity than the ow's. Popular sentiment, however, among the educated classes s against buffalo milk owing to the belief that it is prejudicial to e health of young children. The average buffalo justifies its xistence by yielding 10 to 12 lb. of milk per day, and such an animal worth about Rs. 75 at the present prices. The upkeep of such n animal per day is about 5 annas, while the milk it produces is orth annas 10 to 12 at 1 anna per pound. Cheaper animals can, course, be had which yield correspondingly reduced profits. Their aintenance through the dry period presents no great difficulty. ad milkers are disposed of, as soon as they calve, even at a small ss.

The dairy industry is also carried on as a subsidiary source of come by cultivators who are either tenant farmers or peasant oprietors. These are usually Tamils of whom Goundans, Vellalas, d Konaris claim particular mention. Besides these, there are o sections of the Telugus, namely, Gollas and Kammas, who migrated into these parts from the north and are reckoned to be as od cultivators as their Tamil neighbours.

Among these those who possess garden lands are fairly well-to-do. ey include in their herd a few milch buffalos which supply milk, rds, and *ghee* (clarified butter). The ryot does not keep more ffalos than he can find a use for, but a landlord owning 10 acres uld probably have two or three buffalos in milk, and the rplus milk generally goes to meet the needs of the town. The asant proprietor, however, contents himself with only one, rarely o. The usual custom is to have two animals, one of which is ays in milk.

Of the castes mentioned above, Konaris are professional ders in curds and *ghee*. Their condition is not so prosperous that of Goundans and they prefer cash transactions to monthly ttlements. The trade is entirely in the hands of the womenfolk. keeps a woman fairly independent of her husband for her daily cessaries, besides saving her from earning her livelihood as a day bourer. Though it means a good part of the day spent in the n, she prefers to carry her headload inasmuch as she gets her

business done and contributes her share to the village gossip which she loves so much.

Let us consider the profits of this *ghee* trade. From a buffalo yielding 10 lb. of milk daily, $\frac{1}{2}$ lb. of *ghee* is obtained, according to actual tests. At the present prices this is worth only 5 annas. This is therefore too low a figure to derive any profits from. The *ghee* is, therefore, heavily adulterated so that it fetches nearly the value of 10 lb. of milk. Besides *ghee*, she obtains curds which are diluted to make up 15 to 20 lb. which will sell at about R. 0-2-6. This then is probably the profit in the transaction. At the present rates pure *ghee* manufacture is certain to mean loss, and the only course left to the traders is to adulterate it and thus keep the price as low as possible.

The existence of the College Dairy in this vicinity has created a market for some portion of the surplus milk of the locality. It obtains from the surrounding villages milk totalling up to about 400 lb. daily. This milk is put through the separator, and the cream is pasteurized and converted into butter, which finds a ready sale not only in Coimbatore but in different parts of the Presidency. The average monthly sales of butter alone come to about 700 lb. besides disposing of rich fresh milk obtained from a good herd of cross-bred and country animals (Plate V, fig. 1). A good portion of the separated milk used to be sold at 4 pies a lb., but recently the price was raised to 6 pies and even at this rate there seems to be a good demand. The College Dairy has thus demonstrated an industry to the ryots, to the peasant proprietor in particular, in which class may be included the day labourer and the Government peon whose meagre income is insufficient to support his family in comfort. Even these realize that there is profit in a milch buffalo, and in fact one of the arguments once brought forward by a peon in defence of a second wife was that a buffalo would maintain her !

Yet another industry has sprung up in the last decade in the surrounding tract, which is certainly not indigenous and which is not unworthy of our consideration, if not merely for its intrinsic merit, at least for its popularity among the village folk.

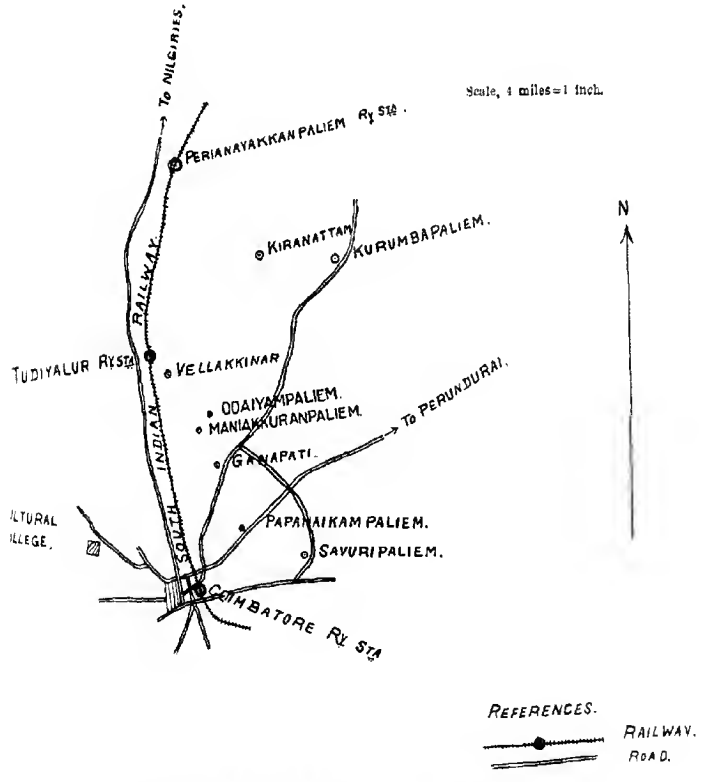
Reference has already been made to the nearness of Coimbatore to the Nilgiris. These hills, besides being the summer

Fig 1. The Coimbatore College Dairy Herd.

2. A creamery man with a separator, and brass vessels. Note the method of packing the tin containing cream ready for transport to the hills.

eadqu rters of the Madras Government, attract in summer umero.is visitors. Besides, the fertile soils of these hills, com-ired with the climatic advantages, offer exceptional facilities r the existence of a fairly permanent population, which, being ostly European, has created a demand for dairy products in the hape of milk and butter. To meet this demand a special industry as been organized.

A little over 15 years ago there came to the hills a yourg Parsee n business. With the foresight and business acumen which seem o be inherent in his race, the Parsee grasped the situation and set himself to solve it. There was a large European population in



Map showing villages in Coimbatore taluk where creameries exist.

need of genuine dairy products. The local supplies were barely sufficient to meet the demands for milk, but where was the butter to come from ? He started with the hill buffalos, but the demand soon outweighed the supply. Then he visited many villages in the neighbourhood of Coimbatore and established a sub-station within a couple of miles of Coimbatore and arranged for an agent who purchased milk in the neighbourhood, separated it, and sent the cream by rail to Wellington, while disposing of the separated milk locally as best as he could. He could hardly touch 50 lb. at that time. The Parsee made friends with villagers, and even went so far as to obtain for them cream separators free, and appointed agents who supplied him with cream. The result has been that to-day there is a chain of villages dotted all along the railway line running north to the hills from Coimbatore (*vide* Map), in which there is a well organized system of creameries, run for all intents and purposes on business lines, and at the present moment without exaggeration it could safely be estimated that about 3,000 lb. of milk are being dealt with daily in the season at these creameries in about nine villages, excluding the town of Coimbatore itself.

The management of the creameries may now be considered. Although the supply of milk is in the hands of the cultivating classes, the management of the creamery itself is not with them. The creamery man is of diverse callings. He may be a petty building contractor, or a discharged cook of a wealthy landlord, or again a poverty-stricken weaver thrown out of his trade. Sometimes he is a Christian originally of an enterprising caste, or a leisured village postmaster, but hardly ever a genuine cultivator. The farmers view this enterprise with suspicion, probably because creameries are speculative concerns and naturally the ryot looks well before he leaps. They, however, admit that there is money in it if properly run. The creamery draws its supplies of milk from the cultivating classes of the villages in the neighbourhood. The creamery itself is a part of the dwelling house often rented for the purpose. It is invariably an ill-ventilated and insanitary corner of a main room in which children play and women cook. Or sometimes if the owner is desirous of having more ventilation, he makes use of the verandah

where pedestrians and flies congregate. To such a place the milk is brought by the village women, frequently in open copper vessels, never earlier than 10 o'clock, and the creamery is at its busiest between that hour and noon. The milk is tested by the lactometer in each case, not filtered but poured into large copper vessels after the quantity is measured. The woman gets her book filled in, and while doing so the creamery man makes a large allowance for any suspected sample. He then records in his register the quantity purchased. Any reduction in milk is generally echoed in a protest, but the woman has the cure for it in her own hands.

To encourage customers to bring more genuine samples, certain creameries adopt different prices for milk, but it is not likely to work very satisfactorily as they rely entirely on the lactometer which at best is only a rough and ready test.

Fat analyses of samples of milk taken at random from some creameries are tabulated below, and give an idea of the standard of quality maintained in them. The milk is invariably buffalo's but sometimes there is an admixture of cow's.

Village	No. 1	No. 2	No. 3	No. 4	No. 5	Average*
	%	%	%	%	%	%
Ganapati	6·5	4·5	3·8	4·2	4·8	
Kiranattam	5·3	5·2	...	...	...	5·4
Savuripaliem	5·4	5·0	5·5	5·4	4·9	...
Papanaikampaliem	3·3	2·1	4·6	3·9	5·5	4·6
Perianayakkanpaliem	7·0	6·6	8·2	8·5	5·2	6·6
Vellakkinar	6·7	7·1	4·8	9·0	...	7·7

* The average sample was taken from a quantity of milk varying from 100 to 200 lb.

Taken all round, except in Papanaikampaliem where the milk is exceptionally bad, the samples are of fairly good quality, and especially so in Perianayakkanpaliem and Vellakkinar which are far from the evil urban influences. The creamery men pay at 16 lb. per rupee in the last named places, while in the others 20 lb. per rupee is the rate.

The equipment of the creamery cannot be simpler. It consists of a separator usually secondhand, the size depending upon the quantity dealt with. The separator is of various makes, but the commonest is Alfa Laval. Diabolo and Heinrich Lang Mannheim are also found. A lactometer (metal or glass), two large brass

vessels, milk measuring cans, and a number of old kerosene tins make up the rest of the equipment (Plate V, fig. 2).

The following is a rough estimate of a creamery as equipped above :—

	Rs.	as.	p.
1 Separator (secondhand) ...	250	0	0
1 Lactometer (metal)	10	0	0
2 Brass vessels	30	0	0
2 Measuring vessels	2	0	0
12 Kerosene tins ...	6	0	0
	298	0	0 or

roughly Rs. 300.

Let us consider the returns of one who has no room rent to pay. It is estimated that 300 lb. of milk produce 1 tin of cream weighing about 36 lb. His expenditure is as follows :—

	Rs.	as.	p.
Cost of 300 lb. milk @ 20 lb. per rupee	15	0	0
Cooly from creamery to railway station	0	1	0
Railway freight on one tin from creamery to Wellington ...	0	7	0
One girl to help in washing up	0	2	0
Depreciation on separator, etc., per day	0	2	0
	15	12	0

The dairyman pays the creamery man at 11 annas for every pound of butter manufactured, and the usual proportion of butter to cream is between 66 and 70 per cent.; so that from 1 tin of cream about 24 lb. of butter is obtained which is valued at Rs. 16-8-0, and this means there is a gain of only a few annas by the transaction. Where then is the attraction for this industry? The townsman has of late found separated milk to be a good substitute for milk. This finds a ready sale in coffee and sweetmeat shops, in Hindu hotels, and in fact even in well-to-do Indian homes. If the creamery is at all get-at-able, there is an excellent sale for separated milk, so that, even at a conservative estimate of 3 pies per lb., there is a net gain of about Rs. 3, provided the whole of separated milk is disposed of. This, however, is not the case. The creameries are not all situated near a large town like Coimbatore. Even those which are more favourably situated, are sometimes unable to dispose of it owing perhaps to a dislocation of trade due to epidemics like plague. Wherever conditions are less favourable, the separated

ilk is converted into curds and sent either to Coimbatore or railed , Palghat where demand exists for curds. If this is not possible, ien the separated milk has to be thrown away. These all mean duction in profits, so that if Rs. 3 per day is obtained under ceptional conditions even a rupee under less favourable circumances is not too little to be ignored. It is clear, therefore, iat the larger the quantity of separated milk sold, the greater ie profits of the creamery.

It may be quite a pertinent question to ask if this enterprise as been successful throughout. As in every other enterprise, this as not been without its pitfalls and some have profited from the ilure of others. It cannot be said that every one succeeds. The riter's attention was drawn to a particular instance where a reamery man believing the words of a wily Mahomedan agent of a airy at Madras, kept sending on cream until his liabilities went as igh as Rs. 1,500; eventually, assisted by his old master, the reamery man threatened to go to law. When settlement was made, e was the loser to the extent of about Rs. 800 in the concern.

The conditions suitable for a successful creamery are : firstly, here should be facilities for the purchase of good milk ; secondly, the reamery should be able to dispose of the major portion of the separated milk ; thirdly, the creamery man must have business instincts ; nd, fourthly, there must be a steady demand for the cream. The mall initial outlay, the little trouble attached to the business, and he quick returns tempt a non-agriculturist to launch on this specuative undertaking. Granting that conditions mentioned above re available, it is undeniable that there is money in this business.

Should we trace the destination of the cream we should find it till more interesting. One would notice while travelling in the norning train to the hills, a number of kerosene tins packed in plantain sheaths arriving at Coonoor and Wellington. They contain ream consigned to dairies. These are unostentatious in appearance. One which did the greatest business had for its activities the outhouses of a modest villa situated in an unfashionable locality of he town. Although the conditions were filthy to the extreme and he methods of manipulation totally crude and unscientific, it was

amazing how fine a product was obtained with the cream which reached its destination in varying degrees of fermentation. The knowledge of technique of the dairyman was nil, his apparatus was meagre, and yet he was daily manufacturing 100–120 lb. of butter at the time of inspection and which he disposed of without any difficulty in the neighbouring hill stations. Thanks to the climatic facilities, the texture of the butter was good, although there was a good deal of room for improvement in the matter of cleanliness. Samples of butter obtained from three dairies are given below which speak for themselves.

Particulars	Government Military Dairy, Wellington	The Nilgiri Dairy, Wellington	Coonoor Dairy	Remarks
Moisture ...	11·72	14·16	7·81*	* Sent packed in tissue paper which absorbed some of the original moisture.
Fat	86·60	84·06	90·43	
§Solids, not fat... ...	1·60	1·61	1·16	
Total ...	99·92	99·83	99·40	
§Containing casein ...	0·39	0·49	0·50	† Mean of two determinations. No. 1 was a very soft butter.
Reichest Meissl number	29·6†	21·7†	22·80	
Refractive Index corrected to 40° C.	1·4549	1·4554	1·4551	

The manufactured article is placed in different sizes on dishes covered over with cloth and sent round to customers who gladly purchase it at R. 1 per lb. The recurring expenditure is small. The water is cold enough to render the use of ice unnecessary. One man is employed in churning and another for selling. Even allowing that he pays 3 annas a pound for initial capital, recurring expenditure, and establishment, the dairyman makes in the busy season a clear profit of 2 annas on every pound of butter manufactured but during the off season he would necessarily manufacture less. This industry demonstrates clearly what an extensive demand there is for dairy products around Coimbatore, and it does not need much imagination to peer through this vista into the future of the dairy industry in India managed with scientific and business knowledge.

THE SEASONAL FACTOR IN CROP STATISTICS: A METHOD OF CORRECTING FOR THE INHERENT PESSIMISM OF THE FARMER.

BY

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STATISTICS of all sorts are usually held to be a very dry subject, t properly considered they may be full of human interest—pecially to the compiler—from the side-lights they throw on the ychology of those who supply the detailed information on which e statistics are built up. The war has shown us how valuable uld be really accurate statistics of the production of the several in crops in India. These figures depend on three factors—area, rmal outturn per acre, and the seasonal factor—which, when ltiplied together, should give the gross outturn.

So far as the Madras Presidency is concerned, the figures of area ailable in arrears at the end of a revenue year are extremely reliable. e same cannot be said for the figures supplied in advance to the Direc- of Agriculture for purposes of crop forecasts, but the modification these so as to approximate more closely to the eventual final ures affords that harassed officer an opportunity for the exercise ingenuity in which a knowledge of the state of the season is not important as an appreciation of the psychology of the village countant and the taluk clerk, and an estimate of the state of partmental discipline of particular districts. A taluk was found ently where no village accountant kept any accounts and where figures were invented at the close of the year, or so it seemed—t that is another story, and for the credit of Madras an exception.

The figures of normal yield per acre are, in Madras, based on a large number of crop cuttings, mostly carried out by Settlement Officers; but it must be admitted that the figures in most cases are only a rough approximation to the truth. The writer believes that the only way to improve them is to abandon the method of averaging a limited number of crop cuttings—which amounts to working from the particular to the general—and to reverse the process and work from the general to the particular. If the total yield of a particular tract can be ascertained, then this total divided by the area under the crop gives the average crop per acre for the year. Do this for a series of years, and we obtain a most accurate figure of average yield per acre. The only crop for which this method has been tried in Madras is cotton. Fairly complete figures of the cotton crops are being obtained from presses and mills so that the average crop per acre for each important tract is now known accurately for two years at least. Cotton is the easiest crop to which to apply this method, because the local consumption for hand-spinning is so small as to be negligible. In the case of food grains, on the other hand, the local consumption is the important factor in estimating the total yield, but the writer believes that it would not be impossible to form a fairly accurate estimate of the total yield of a staple food grain in a particular tract by a consideration of the average annual consumption per head of population together with the statistics of export and import by rail and sea.

Thirdly, there is the seasonal factor. Any estimate of the total crop based on statistics of exports and mill and factory consumption must of necessity be made in arrears, after the crop has been sold and moved. Such statistics can be used to tell us what the average crop per acre of the previous year *has been*, as explained above, but they cannot of themselves tell us what the current crop *is going* to yield per acre, and it is this information which is required of us by merchants, railway companies, and the public generally. To obtain this we must form an estimate of how the current crop differs from our normal average standard. In Madras such an estimate is framed by each village accountant. The area under

of the crops in his village is classified by him under one of heads, *i.e.*, 16 to 13 as., 12 as., 11 to 8 as., 7 to 4 as., 3 to 0 as. area under each of these heads is totalled for the taluk and district and a weighted average struck, and this is then reduced a percentage, taking 12 as. as equal to 100 per cent. Until year the figures thus obtained were published by the Board evenue, in the annual Season and Crop Report, as the percentage normal crop obtained in each district. Now the village account- like most farmers, is a pessimist and thinks poorly of most as. He is told that 12 as. represents a normal crop, but to him ormal crop is the crop he would like to see, but rarely does see. sequently the final integration of the estimates of the large iber of village accountants always works out at very much ow 100 per cent.—it is usually nearer 75 per cent. This is only it is to be expected. A normal average crop is not easy to isage. It is difficult to bear in mind that the average crop r a large tract would have its fair share of crop troubles of all ds. If shown a really average crop most of us would see sufficient lts in it to put it down as much below 100 per cent. The same ag will be noticed in the American cotton forecasts where the ondition figure" of the crop is always below 100 per cent. This t is frankly recognized by the American Department of Agricul- e and explained by stating that the normal crop which corre- nds to their 100 per cent. is admittedly a crop without any serious ects and therefore considerably above an average crop.

As stated at the beginning of this paper, the total yield of a p is estimated by the following formula :—

Total yield = Area × average yield per acre × seasonal factor.

Now to obtain an accurate result the second and third factors ust refer to the same standard. If the second factor referred a normal crop which was considerably above the average, then would be right to take the yield of this "normal" crop as the 0 per cent. standard for the seasonal factor, and not the yield an average crop. But even the method of averaging crop cuttings ade on good, bad and indifferent crops gives something much arer the *average* crop than a fictitious "normal" crop, while

the method of calculating this second factor by dividing the aver total yield by the average area, as recommended above, gives emphatically a real *average* crop and not any imaginary "norma

It therefore follows that our third factor should refer to a rea average crop and not to the good crop without defects to wh the village accountant now instinctively refers it. A method effecting this has been suggested by the writer and has been adop in Madras since last year. The question is, "What is an aver crop?" The answer, which seems obvious when stated, b which does not appear to have been so stated before, is "the cr which the village accountant reports over a series of years." Ta for instance, a district where the integration of the estimates of the village accountants has yielded the following percentages of normal crop of, say, rice :—

	Years.										Average for 10 years
	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	
Percentage of "normal" crop ...	68	79	72	85	81	74	72	83	67	75	75·6

Now, assuming that 10 years is a long enough period to ta to eliminate seasonal fluctuations, it is perfectly obvious that a average crop in this case is the crop which the village accounta marks as 75·6 per cent. on his scale. (We may also deduce th the accountant's mental standard of a "normal" crop is one whi is $\frac{24{\cdot}4}{75{\cdot}6} \times 100 = 32{\cdot}3$ per cent. *above* the average.) Now suppos that the seasonal factor for the year 1916 works out, on the sam basis, as 83 per cent. We then know that this season's crop, so fa as we may judge from the village accountants' estimates, is *bette* than the average, and can be represented by $\frac{83 \times 100}{75{\cdot}6} = 110$ per cent. if the average crop is represented by 100 per cent.

The process described above consists essentially in adjustin the middle point of the village accountant's scale of estimatin so as to make it coincide with 100 per cent. Anything abov 100 per cent. then represents a crop above the average of the pas

rears, and *vice versâ*. Considering that the figures with which are dealing represent the sum of a very large number of small ervations, we can place considerable reliance on them as being elated with real differences in the crops of the different seasons. first thing necessary to enable us to make good use of these res is to reduce them to a fixed standard scale, and it is claimed t this has been done by the method explained above. It is bably enough to take the average of 10 years as our standard, if not, it is just as easy to take 20 years or even longer.*

It is also probable that the scale could, with advantage, be adened out, either symmetrically or asymmetrically. It is umed at present that a 16 as. crop is double, and a 4 as. crop half, of an 8 as. crop, whereas the real ratio may be different. t to evolve a formula for this correction would imply a detailed dy of the variation in yield of crops with season and the correla- n of this variation with the village accountant's estimates, a ce of research which has not been taken up.

It may be mentioned that the correcting factor, *i.e.*, 100/75·6 the case taken above, should be worked out separately for each p, and for each district. A detailed study of the figures shows at great variations exist between different crops and districts Madras. For instance, sugarcane is always estimated at some- ere near 100 per cent. presumably because it does in fact vary y little in yield under the conditions of high cultivation and ntinuous irrigation. And it is evident that the mental image a normal crop formed by the village accountant is influenced the gross yield of his village as compared with that of adjoining cts. For instance, the rice lands of the Coimbatore District e mainly concentrated in very fertile strips along the banks of e Cauvery and its tributaries, while the few remaining rice lands the district are irrigated from rain-fed tanks and are compara- ely inferior. Consequently the average estimate (uncorrected) for e in Coimbatore usually comes out at nearly 100 per cent., the good imates made for the fertile strips outweighing the low estimates

* It has now been decided to take all years for which figures are available.

made for the small area of poorer lands with which they are mentally compared.

This method of correcting for the natural pessimism of a crop estimator can of course be applied to the estimates made by any agency, even to cases where the seasonal factor is estimated for whole districts by one officer. But when the number of estimates with which we are dealing becomes few, the effects of changes in the estimating staff, or even in the point of view of the individual officer, become more marked, until a point is reached at which it is not safe to take the average of past years' estimates as a standard. We lose, in fact, the smoothing-out effect of large numbers, which in the case of the estimates framed by village accountants, gives us a firm basis on which to work.

HE NEED AND OBJECTS OF A SOIL SURVEY IN THE PUNJAB.

BY

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THE object of this paper is to draw attention to the need in ndia of systematic soil surveys. The paper was originally read efore the Lahore meeting of the Indian Science Congress, but has ince been somewhat altered and extended.

The elaborately organized work of the American Bureau of oils is an example of what a systematic survey can do for the griculture of a country. The productive capacity of the soil and ts peculiarities must always be the first consideration in applying cientific methods to agricultural practice, and it is only with such nowledge at its disposal that the Agricultural Department can ope, with confidence, to educate the cultivator in the best methods f working, and the most suitable crops for his conditions. Besides ne direct profit to the cultivator, for which the work of the American ureau of Soils has been responsible, in suggesting new and more rofitable crops in localities where they had not previously been ntroduced, and in explaining and indicating the remedies available or the treatment of infertile soils, the accumulated results of years rovide most valuable data for the soil scientist all over the world.

Work on more limited districts has been conducted on the ines laid down in the classical work of Hall and Russell in many f the counties of England and Wales and has had far-reaching esults.

With the exception of limited areas in India, no systematic survey of soils has been possible in the short time the Agricultural Department has been in existence. Confronted with the enormous field of work which is open to the investigator of Indian agricultural problems it is not surprising that amongst much that has been done there still remains the formidable task of standardizing the results. Besides the submergence of this necessary work by the mere press of other and obvious problems, two tendencies must be recognized as deterrent. The first is the tendency to investigate the abnormal rather than the normal; the second is the practice of referring analytical results obtained in India to the standard types isolated by workers in other countries, England and America. In the absence of a thorough knowledge of *normal* Indian soils and their agricultural properties, this is the only course which can be adopted at present. But the necessity of detailed study of our own soils must not be lost sight of. When the influence of the various factors which so profoundly modify the properties of soils, which from their chemical and mechanical composition seem similar, has been thoroughly elucidated, the practice will be admissible and profitable, but not till then.

Besides the direct agricultural value of a thorough knowledge of the typical soils of a district, a soil survey should prove of use to the Revenue Department, especially in connection with settlement.

A more direct application is to be found in uncolonized tracts which are capable of irrigation. A trained staff, with sufficient systematized experience behind it of soils in similar tracts, should prove of great value, firstly, in determining the prospective value of the land which it is proposed to bring under cultivation; secondly, in influencing the design of the canal system; and, thirdly, to the Colonization Officer when the district comes to be settled. My point can best be illustrated by reference to actual examples.

The Lower Bari Doab Canal was designed to irrigate 871,000 acres, and was expected to derive Rs. 38,51,109 in revenue. Five main types of soil are recognized: *Bara*, *Barī*, *Maira*, *Kalrathi*, and *Dhaya*. Bara soil is characterized by intense hardness. It is quite

ert, and rings when struck as though it were cast iron. The age is a characteristic feature of the landscape where this soil present. It is usually low lying, and water stands on it for a g time.

Bari soil is similar to Bara but not quite so bad. Kalrathi a rather different type of soil characterized by a hard crust which ntains considerable amounts of alkaline salts. The crust is ll defined and can be cracked off, the thickness varying from to 4 inches.

Maira is a loose sandy soil, and Dhaya is very uneven land of locks and ravines. The area covered by these types is as follows:

	Acres
Bara	104,163
Bari	75,093
Kalrathi	78,583
Maira	49,706
Total ...	307,545

Of this the Revenue Department consider 121,091 acres as oblematically culturable, while the residuum, 186,454 acres, classed as unculturable. Thus 23 per cent. of the total commanded ea is bad land.

The annual land revenue and water rate (gross) on this area ust be put at Rs. 12,00,000. If we take it at Rs. 10,00,000 net is over one quarter of the total net revenue (Rs. 38,51,109) expected on the Lower Bari Doab Canal and over one-eighth of the total net come expected from the Triple Canal Project as a whole.

Unfortunately, the survey was made after the canal was under onstruction. Now the canal is there, all that remains, in order to ve the project from financial failure, is for the Agri-ultural Department to see what can be done with the 186,000 res "unculturable soil" and 121,000 acres "problematically ulturable."

The process of canal colonization is seen in its early stages in he case of the Sind Sagar Project. Between the Indus and the henab we have the districts of Mianwali and Muzaffargarh, which re mainly arid regions with scattered and small tracts where well rigation is practised. The scheme is to draw off water from the

Indus at Mari for the irrigation of this tract. The rough project is being drawn up on results of previous Government of India surveys. The Survey Department will now make a detailed survey before construction commences. Some analyses of soils of this district have been made by Hooper, which are reprinted in Table I. Only chemical analysis is available and the samples are too scattered to obtain any very clear idea of the nature of this soil. I understand from officers who have toured in this region, that a large proportion of the soils are sandy, and this fact, apart from their agricultural value, should be taken into account, in designing the canal, by the Irrigation Department. An examination of the permeability of the subsoils would enable a prediction of the possibility of dangerous seepage to be made, and would thus allow of the adoption of preventive measures, such as water-proofing, in the design. The importance of taking seepage into account in the design is fully realized by the Irrigation Department, whose experience in other colonies has shown the difficulty of attacking this evil once the canal is built.

The supply of water in the five rivers is not inexhaustible, and there must be competition between the large tracts which are yet open to irrigation, for the wealth they bring. The probable value of the land, when irrigated, must be known when deciding conflicting claims, and this knowledge can be obtained only by a systematic soil survey.

The first step in systematizing our knowledge of soils is, of course, to devise some method of classification. In the Punjab we are dealing for the most part with a vast tract of alluvial deposit, and consequently a geological basis of classification, as has been used in other countries, is impossible on account of the lack of differentiation. This does not mean that the diversity of structure and agricultural properties of the soils met with will be less marked.

The American Bureau of Soils bases its primary classification on the origin of the soils; this first classification results in the establishment of large soil "provinces." The next subdivision is effected by considerations of colour, subsoil conditions, etc., and enables a classification into "series" to be made. The "series"

TABLE I.

	I. Surface of Tha			II. Hard soil of the Hills				III. Blown sand				IV. Root sand	
	1	6	20	5A	34	50	51	9B	32	57	75	14	27.31
Iron oxide	2·80	3·20	1·60	1·80	4·60	2·60	2·00	1·40	2·60	1·60	1·80	2·80	2·00
Alumina	2·00	2·7	3·15	1·40	6·30	3·57	3·02	1·15	2·40	1·51	1·31	1·75	2·45
Potash	0·21	0·39	0·06	0·06	0·15	0·25	0·14	0·11	0·10	0·06	0·05	0·12	0·10
Phosphoric acid	0·09	0·24	0·13	0·11	0·20	0·21	0·22	0·23	0·18	0·09	0·07	0·23	0·15
Carbonic acid	4·65	3·40	3·21	2·75	7·36	5·79	2·64	1·50	3·91	1·75	1·18	2·00	2·26
Insoluble silicates	83·36	81·18	86·22	90·04	64·46	80·42	86·00	92·18	85·28	92·24	93·00	89·02	88·61

are then divided up into "types" according to the mechanic constitution of the soils composing them.

The value of mechanical analysis in the examination of so is too universally recognized to need much comment. In t Punjab, this must serve as our main basis of classification. A Lyallpur a centrifugal method of separating clay and silt fractio as introduced by the American Bureau of Soils, has been adopt and found to give satisfactory results with a great economy of tim A specially constructed shaking-machine enables twenty-four sample to be prepared for analysis at one time.

A simple method of classifying soils, based on their mechanic analysis, is required when dealing with a large number of specimens The series of figures by which the result of analysis is usually expressed is not easily comprehended, or amenable to a system o cataloguing. A graphical method has many advantages, since th position of a soil, with respect to standard types, can be seen at a glance. Moreover, it is possible to indicate by the size of the circ representing a soil the limits within which variation is allowab for a particular soil. The method which I have adopted provisio ally consists in plotting on a triangular diagram the percentages o silt, sand, and clay. This has several advantages over the metho adopted by the American Bureau of Soils for the purpose, sinc the percentage of the third component can be read off the diagra at a glance. The diagram used by them is reproduced as Diagram I. It must be remembered that the sizes of the fractions corresponding with silt, sand, and clay, differ in the two cases, as shown in Table II below. This accounts for the fact that soils appear to be classed

TABLE II.

Limits of diameters in millimeters	SAND		SILT		CLAY	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
American ...	2·0	0·05	0·05	0·005	0·005	...
English ...	1·0	0·04	0·04	0·002	0·002	...

as clays in one diagram which may contain 5 per cent. less of the constituent than the other. Thus in American analyses all particles of

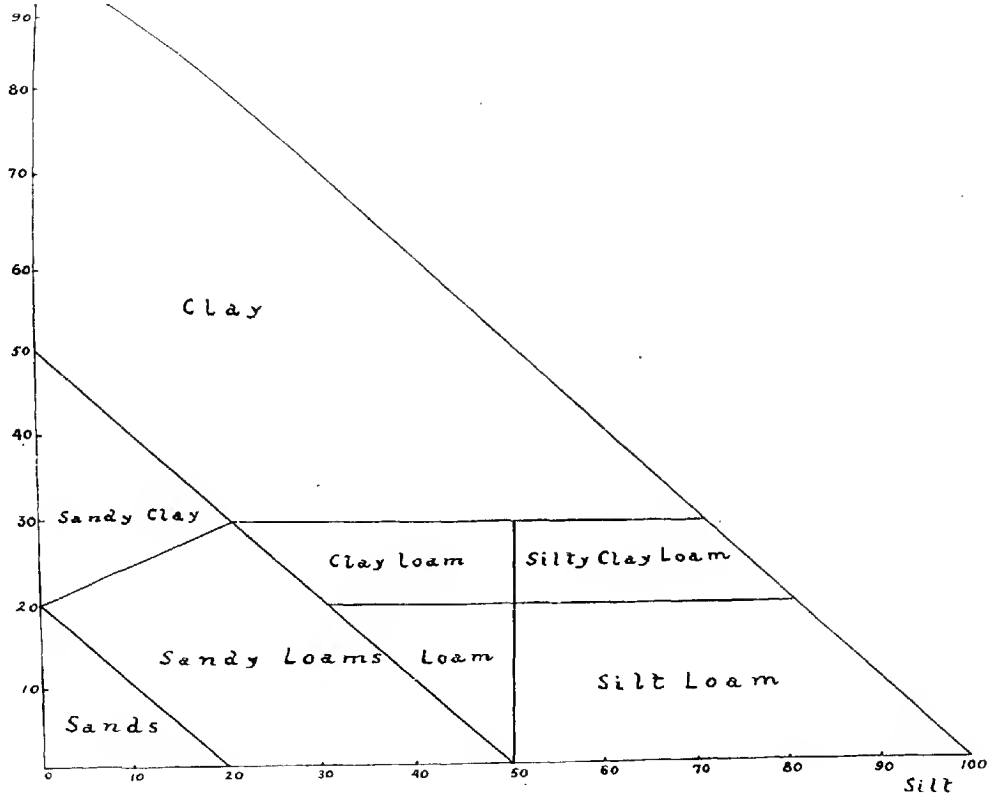
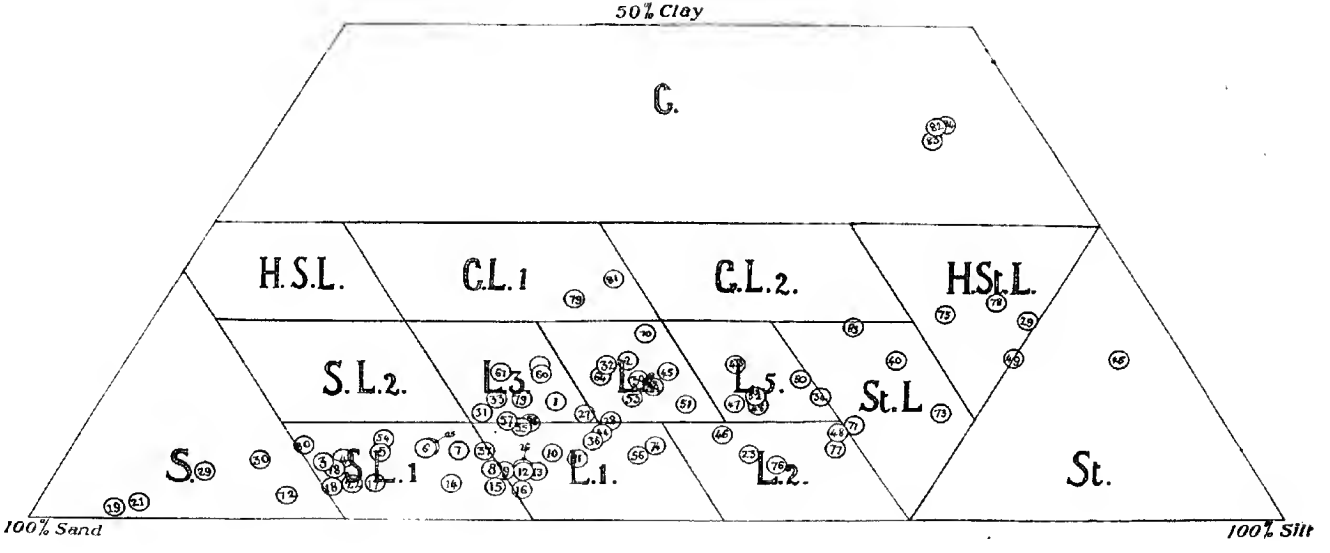

90
80
70
60
50
40
30
20
10
Clay
Sandy Clay
Clay loam
Silty Clay Loam
Sandy Loams
Loam
Silt Loam
Sands
0
10
20
30
40
50
60
70
80
90
100
Silt

Diagram I.


50% Clay
C.
H.S.L.
C.L.1
C.L.2.
HSt.L.
S.L.2.
L3
L5.
St.L
S.
S.L.1
L.1.
L.2.
St.
100% Sand
100% Silt

ss diameter than 0·005 mm. are considered as clay, while in glish analyses 0·002 mm. has been fixed as the maximum limit. e fourteen compartments into which the diagram has been vided, represent mechanical constitutions within the following mits.

TABLE III.

Description	Percentage		
	Sand (+0·04 mm.)	Silt (+0·002 mm.)	Clay (−0·002 mm.)
and	+75	−25	−25
andy Loam I	+60	−40	−10
,, ,, II	+60	−30	−20
eavy Sandy Loam	−75	−20	−30
oam I	+45	+30	−10
,, II	−45	+45	−10
,, III	−60	+20	−20
,, IV	−50	+30	−20
,, V	−40	+40	−20
ilt	−30	+50	−20
eavy Silt Loam	−20	+50	−30
ay Loam I	−60	−40	−30
,, ,, II	+20	+30	−30
ay	−70	−70	−30

NOTE.—A + sign is placed before a minimum limit, and a − sign before a maximum.

Diagram II contains analyses selected from Punjab soils and ubsoils. Nos. 1 to 30 are Lyallpur soils: 31 to 38, Gurdaspur; 9 to 70, Montgomery; 71 to 75, Karnal; 76 and 77, Rawalpindi; nd 78 to 84, Kangra.

This method of classification does not take account of the ubdivision of the sand and silt fractions, which is effected in echanical analysis, and therefore does not afford a complete repre-entation of the constitution of a soil.

For classification, however, while the broad types thus istinguished may be sufficient for most purposes, it will be dvantageous to devise a method by which the description of the echanical type to which a soil belongs may be made as complete s possible.

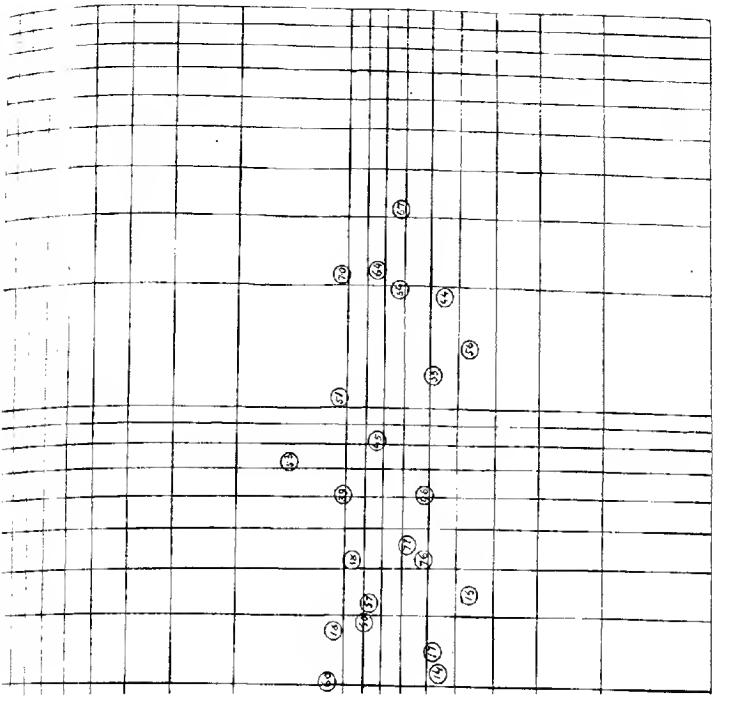
For further differentiation of the soils falling within the com-artments representing the main mechanical types, the method of plotting the logarithms of the ratio $\frac{\text{fine silt}}{\text{silt}}$ and $\frac{\text{fine sand}}{\text{coarse sand}}$ has

been found to afford a ready graphic method. Diagram III shows this done for soils of the types L1, L2, L3, L4, and SL1. It will be seen that soils which, from their position on the triangular diagram appear to be widely different in character, show up relationship with one another which would not be expected. This fact may have some bearing on the similarity of origin or condition of deposition or alteration of the related soils so associated, but more data must be forthcoming before any definite conclusion can be drawn on this point. Thus most of the Montgomery soils obviously fall in a class together. Standard types of English soils show greater similarities with Gurdaspur soils, but several are unrepresented by Indian example in the soils included in the diagrams. By dividing this diagram up into areas, it would be possible to arrange a system by which a soil which falls in a certain compartment should have this indicated in the type "formula," but more data, and particularly data as regards the agricultural properties of the soils must be forthcoming before any system proposed can hope to be anything but conventional. Except for the fine gravel a type formula such as is proposed would provide a complete expression of the mechanical composition of a soil. It must be clearly recognized, of course, that the importance of mechanical type may be over-estimated as regards the agricultural properties of a soil: all that is proposed in this paper is that it may be made to serve as a reliable and convenient basis on which the study of soils may be conducted.

As has been pointed out by Hall and Russell, in the present state of our knowledge this must be an empirical process. Agricultural properties must be determined by observation. The reaction of the soil to manures cannot at present be predicted from a knowledge of the chemical composition of the soil alone.

By far the most important factor, particularly in the Punjab, is the behaviour of water in the soil. Hall and Russell have stated, "indeed one can go so far as to say that a mechanical analysis can only be fully interpreted in terms of the water-supply. It is of course not the properties of the fractions that change as the

Diagram I



crops and manures, found empirically. Cultural treatment, etc.

can only be fully interpreted in terms of the water-supply.
is of course not the properties of the fractions that change as t

ater-supply changes, but the relative importance of the part they ay in crop production." The actual medium in which plant growth kes place is not the only factor. The character of the subsoil ill have a great influence on the moisture equilibrium in the soil d data on the point should be collected. In the Punjab, where much of our agriculture is dependent on irrigation and where matic conditions are so constant, we have a great opportunity determining the relative importance of these factors.

We may summarize the factors which must be studied in a soil rvey under four heads. These are, firstly, the *constitutive* roperties, by which is meant the unalterable properties of the onstituent particles of a soil. Secondly, *additive* properties, by hich is meant those properties of a soil which may be expressed s a sum of all the properties of the individual particles composing it. hirdly, *colligative* properties, which, while depending on the roperties and relative amounts of the individual particles, by reason f their interaction on one another, cannot in the present state of ur knowledge be calculated. Fourthly, we may class together s *accidental or variable* all those properties which are under the ontrol of the agriculturist. Under these four heads we may ention the following factors, which it is our ultimate aim to be ble to correlate with the agricultural properties of soils mentioned nder (5).

(1) *Constitutive.* The mechanical and mineralogical constitution of the soil and subsoil.

(2) *Additive.* Physical properties, *e.g.*, specific heat, density, surface. Total chemical composition.

(3) *Colligative.* Moisture equivalents. Pore space, transmission constants, available aualysis, the determination of the composition of the soil solution.

(4) *Variable or accidental.* Organic matter content, aggregation (flocculation). Salinity, acidity, or alkalinity. Subsoil water level, etc.

(5) *Agricultural properties.* Behaviour of the soils with crops and manures, found empirically. Cultural treatment, etc.

The study of all these factors is necessary and no one class of more importance than another. For the separation of soils in types, as a basis of classification, properties must be used which a truly constitutive. Additive properties merely give us the res of the summation of the variants; colligative properties we are n yet in a position to understand. In this paper the use of mech nical analysis is advocated for the purpose. At present the seems no need to make the broad fractionation of particles at prese conventional, of greater fineness, but as our knowledge increas this may be necessary. All that is proposed in this paper is method by which the ordinary mechanical analysis can be mad of greater application for the description and classification of soil

As regards the Punjab, steps are being taken to provide th necessary staff for this important work. The question of the org nization of similar surveys in the other provinces of India wi probably arise in time, and when this happens, it is to be hope that it will be possible so to co-ordinate the work that result obtained in one province may be available and of use to worker in another. This is a question of standardizing methods and th provision of complete information of the soil types studied.

The actual survey work will probably best be conducted b the Provincial Agricultural Departments, but some central bod for the co-ordination of results will be necessary. Without a prope organization and a specially trained staff, the characterization an study of soil types will be a very slow process. Moreover it i essential that the analyses should be rigidly comparable. If th lines of work were laid down, in the ordinary process of routin analysis, much information, which would be of subsequent use would be collected. A proper organization would, however probably amply repay the cost of its maintenance by its direct agricultural value and the speed with which a sound basis for the application of the Science, which it is the aim to secure for agriculture in India, would be attained.

SOME AGRICULTURAL ASPECTS OF THE HOSUR REMOUNT DEPÔT.

BY

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A REMOUNT DEPÔT naturally implies horses, and horses have to be fed. Consequently a large share of the activities of the establishment are devoted to the production of keep in all forms. The agricultural side of the depôt is thus an important one, and it is with this aspect that this note mainly deals. It would of course be possible to grow *all* the food, both bulky and concentrated, that is wanted, but for various reasons this is not practicable: it would imply a very much larger area, and more extensive staff and accommodation than is desirable. It is clear, however, that every effort should be made to produce the *bulky* fodder needed, owing to the expense of freight, and the special value that fresh fodder possesses, and so we find the land which forms part of the depôt devoted wholly to the production of fodder of one kind or another. Even of this, sufficient is not produced on the estate, and a considerable quantity has to be procured from outside, both dry and green.

The Hosur Depôt is situated on undulating red soil of lateritic origin, of varying depth and fertility. The lower lands, receiving the wash of the uplands, consist of a deep dark brown to grey sandy loam, while the uplands are sandier, and paler and redder in colour: both have the disadvantage, which is so often found on these soils, of baking very hard on the surface when dry, and at

the same time being uncomfortably sticky when moist. This does not make them any too easy to cultivate.

The area comprises both dry and wet lands, the latter being fed from a small rain-fed tank, and being naturally at the lower end of a valley. This circumstance increases the sharp distinction drawn above, between the dry uplands and the irrigated bottom lands.

An additional water-supply would have great value, but, in view of the fact that a boring has been taken down nearly 200 feet without success, it does not seem likely that such can be obtained.

The problem, then, is to produce the greatest quantity of nutritious fodder with the means available, and here the manure-supply is undoubtedly a great factor. The quantity available is much greater than would naturally be the case in any system of arable farming, and it is, from the circumstances of its production, undoubtedly of good quality. It is no doubt to constant heavy dressings of this substance that the change in colour of the bottom lands is largely due.

On these lands, lucerne is the staple crop, and a very good crop is obtained, though not without certain difficulties. Rats or moles damage the plants considerably by gnawing the roots and gaps are consequently formed in the field. The crop also suffers, but not severely, from blight. These, and the plentiful crop of weeds, limit the life of the lucerne to about two years, after which the land is ploughed up and replanted. I was told that something over 200 lb. of (green) lucerne was obtained at a cost of one rupee, and the annual acre yield is in the neighbourhood of 25 tons. This yield is large, and the land is probably yielding its maximum. About the best method of sowing the lucerne, there is less certainty. The two methods found practicable are flat drills with frequent inter-cultivation, or beds with a cessation of weeding after the first six months, when the crop has become fully established. The question is perhaps mainly one of weeds, and these are certainly troublesome, but on such a short visit it is not possible to dogmatize. The absence of any rotation is what strikes an agriculturist, and it might be well to consider the possibility of a cleaning crop a

tervals: either a smother crop of thickly sown *Sorghum* (*jowar*: *olam*) or Bulrush millet (*bajra*: *cumbu*) mixed with some pulse; or widely spaced crop, in which intercultivation could be practised p to a late period. The former is probably the better as a heavy it of fodder would be obtained at the same time. Rhodes grass id Guinea grass are also grown on a fairly large scale; the former as shown itself an excellent cropper.

A word may be said here about the cultivation, which is largely rried out by horse-power. For this of course no charge has to reckoned, but a man is needed for each horse and a third for e plough so that the saving is not so great as it seems at first. he plough I saw in use was a long-breasted type, an old-fashioned oward's Bedford plough, with two wheels, ploughing to a depth of ur or five inches. It would be more economical to use a rather eeper plough, such as the S. A. E. or Steel Eagle, with or without re-carriage, and by yoking more horses save on the number of men. here is little doubt that on both classes of lands. deeper cultivation ould pay. In fact, trenching, which implies the thorough inversion f the soil to a depth of 2 feet, is occasionally practised with success, ough at considerable expense.

The next class of lands are those lying fairly well down the opes. but without facilities for irrigation, and these are mostly own to permanent grass. The treatment of these lands is usually take one or more crops of hay off them, and then to graze them r a period. The fertility of the land, which is obviously high, maintained by dressings of stable manure. These pastures are garded with some suspicion by an agriculturist, to whom the ltivation and regular cropping of the land appears more natural. ut there is little doubt that, in the conditions of rainfall and imate which obtain here, some of these pastures, for they vary ery much in quality, are providing as much fodder as the land ay reasonably be expected to produce. Provided grass can eep growing throughout the year, a condition which does not sually obtain on the plains, it can take full advantage of any rain- ll that is received, which is not the case under any system of ry cropping.

It is when we come to the higher lands that the system of keeping the land in grass seems to fail. Not only are the grasses seen here poorer in quality, but they do not cover the ground and of course give a very much poorer cut. Such lands would almost certainly bring in more fodder, if brought under the plough, though different opinions may be held as to the extent to which this change could be profitably introduced.

The matter is not easy, even with unlimited power, and a large supply of manure. The lands are unkind, and are a very good illustration of the need of judgment in deciding when the various operations should be performed, and the necessity for speed in carrying them out. A few days' delay may result in the land baking to an absolutely brick-like consistency, with the result that all chance of getting a good tilth is indefinitely postponed. And then the weeds have to be remembered. Certain of the deeper rooted grasses, among which *Cynodon dactylon* and *Panicum repens* may be mentioned, probably preclude any rotation of arable crops and pasture land, and it would be necessary to decide once for all which system was going to be adopted in the case of any particular field. The crops to be grown must be decided by trial: mixed fodder crops hold out the best chance of success, with "fall" ploughing as soon as the crop is cut—which could probably be done with a machine—in order to get the land up before the hot weather. This should improve the tilth, and kill the weeds, and it is in these two directions that the causes of the failure of the crops that have been tried must be sought.

The agricultural problems are, as I have tried to show, not without interest, in view of the special conditions which obtain. The few suggestions made above are put forward with some diffidence, as indeed must always be the case where the full agricultural year has not been experienced.

GOVERNMENT CATTLE FARM, HISSAR.

BY

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Chief Superintendent, Civil Veterinary Department, Punjab.

THE following is a very brief history of the Hissar Farm since
s establishment in the year 1809. In that year it was placed in
e hands of Major Lumsdaine and used as a camel-breeding farm.
1815 cattle-breeding and horse-breeding for the supply of stallions
re added. Hissar appears to have continued as a horse-breeding
ntre up to 1848 or 1849.

In 1853 it was decided to restrict operations to breeding
llocks for transport and ordnance purposes, and in 1854 the farm
s transferred from the Commissariat to the Stud Department.
was worked under Mr. Taylor, who held the appointment until
s death in 1865. He was succeeded by Captain T. Robinson,
ho carried on the farm until 1874, when it came under the notice
the Stud Commission, with the result that it was again transferred
the Commissariat Department, in whose hands it remained until
committee appointed in February 1898 recommended that it
ould be handed over to the Civil Veterinary Department for a
riod of seven years, and on 1st April, 1899, it was taken over
that department and has remained in its charge since.

The first officer in the Civil Veterinary Department to hold
arge was Major Gunn, who was Superintendent from 1st April,
99, till 1902.

I took over from this officer and remained in charge until
th June, 1912, when I was transferred to the appointment of
ief Superintendent, Civil Veterinary Department, Punjab, and

Mr. Branford took my place. The farm is situated in the Hissar District of the Punjab and comprises an area of 40,000 acres. The land before the Civil Veterinary Department took over had only about 500 acres set apart for cultivation, but now there are about 2,000 acres. These areas are divided into five blocks (Stables, Kherwan, Chaoni, Mundiawala, and Sully). These blocks have been enclosed and the fields carefully mapped out and numbered and the area of each noted on an iron plate. This work, owing to the great difficulty to be contended with in removing trees, jungle growth, levelling lands, etc., took some time, and the results have been very satisfactory.

The water-supply comes from the Western Jumna, but unfortunately the farm being at the tail-end does not always get the full amount necessary in spite of the water-courses having been improved. The crops chiefly sown are oats, *jowar* (*A. Sorghum*), *guár* (*Cyamopsis psoralioides*), and lucerne.

Oats, if required, are cut green and supplied to the stock, then allowed to grow again for seed and *bhusa*. Green *jowar* is also cut and supplied to the stock, and ensilage is also made with it. There are 25 pits for this purpose. There are large tracts for grazing parts of which are set apart for making hay. The best grass is *Pennisetum cenchroides* [ver. *anjan* (Bagri), *dhaman* (Punjabi)].

The farm buildings comprise the following and are situated some miles apart.

(*a*) Home Farm Block, consisting of 15 large, walled enclosures with stabling and veterinary hospital, godowns, workshop, stackyard and Deputy Superintendent's house.

(*b*) Stable Block, consisting of 10 enclosures and stabling.

(*c*) Chaoni Block, consisting of 13 enclosures, stabling and Farm Overseers' quarters.

(*d*) Sully Block, consisting of 8 enclosures, stackyard, stabling, and Overseers' quarters.

At the Home Farm all stock requiring more careful supervision is kept; such as cows about to calve, ponies and donkeys about to foal, sick and debilitated animals.

At the Stable Block only heifers are kept in the cold weather. the hot weather they are transferred to Kherwan. At the oni Block all male and castrated stock is kept. This place situated on the opposite side of the railway line, so that the stock mable to get near the cows and heifers on the farm.

The Sully Block is about five miles away from the Home Farm l due north of it. In this place all the brood stock is kept.

Since the Civil Veterinary Department took over charge arate grazing paddocks have been made for pony mares, mules l donkey stock.

Owing to no policy of continuity and constant changes of officers he Commissariat time, the Civil Veterinary Department took over heterogeneous lot of stock of the following breeds: Gujarati ankreji), Mysore (Amrat Mahal), Sindi, Nagori, Hissari, and Nellore l their mixed offspring, with the result that heavy weeding had to done. This work was started in 1902, when 1,500 cows were cast and bulls selected with the view of evolving a type. This, as all breeders ow, took time and the work was very difficult, as the registers pt up in the Commissariat time were very impertect and I had to y on types which I considered the best. All the Mysores or rather se showing Mysore, Nellore, and Sindi characters have been minated. The specially selected bulls are issued to the District ards in the Punjab at Rs. 200 each, and are producing very good ck. Foreign buyers are constantly asking for permission to purase bulls and cows from the farm. Two thousand rupees was ered for a bull last year and would have been taken but for shipping fficulties. Several young bulls have been sold for Rs. 500 each. ws have been sold for Rs. 250–400 each. This all speaks for itself.

All male stock not up to the standard for breeding is castrated d issued to heavy batteries for Rs. 150 each. Heifers under andard are weeded and sold to zemindars and others are auctioned. he stock on the new farms in the Punjab has been purchased the owners from the farm.

There are at present 1,500 cows, 1,900 male stock, 1,679 heifers, pony mares, 100 donkey mares, 136 mules, 600 sheep, 197 donkey lts, 7 jacks, 2 pony stallions, 1 Arab, and 4 Arab mares.

With the 1,500 cows there is one bull to every 50 cows. The bulls are very carefully selected, and put with the herds at 4 years of age and weeded out if their stock is not good. A herd bull generally lasts until it is 10 years of age.

A register is carefully kept of all the stock, as is the case with the bulls. The cows are weeded out if their stock is not good. A cow is weeded out for age generally at about 12 years.

A small herd of Montgomery cattle is kept to supply bulls of this breed wherever required.

All the stock on the farm is branded on the left quarter with the age brand, and on the right quarter with a brand showing the serial number of the year in which it was born. These brands are entered in the register so that the pedigree of each animal can be traced. A detailed note of calves born is kept. If the calf is a weakling and dies or develops badly, etc., it is noted; if the bull or cow produces several of these it is cast. Barren cows, or cows giving insufficient nourishment to the calf, are weeded out as early as possible.

Bulls are issued to the District Boards between the ages of 3 and 4 years. About three months before issue they are taken up nose-strung, stall-fed, and handled to quieten them. All young stock is inoculated for black quarter at the age of 6 months when they are weaned. The females are transferred to the Stables where the heifers are kept and the males to Chaoni.

The heifers are carefully selected at 3 years of age, when the best are transferred to the herds. The males are castrated when they are nearly 3 years of age. They are then taken up nose-strung, stall-fed, and handled ready for issue to heavy batteries.

Pony mares are kept for two purposes—for breeding Arabs and mules. There are now 4 pure Arab mares on the farm and 1 very good Arab stallion. This scheme has only just been started and it is expected to be a success. The Arab stallion is also allowed to cover selected zemindars' mares. The mares for mule-breeding are a good lot and the mules produced are issued to mountain batteries; any not coming up to that standard are issued as maxim gun and transport mules.

Donkey mares. This scheme was started in 1903. I was ıted to purchase the best country-bred mares available. These e crossed by an Italian jack, "Calcutta," for a short period, n a change was made and an American jack was used; then ther stallion, "Farmers Boy," and other farm-bred jacks were l. The donkey stock on the farm is good—a very few of the country-bred mares are left. The stock is carefully weeded only the best fillies are kept, the rest are cast and sold. The e stock are also carefully selected before being transferred to rict Boards as stallions. Mr. Branford is now inseminating key mares with pony stallion semen and one has given birth jennet.

Sheep-breeding. This scheme was started with a view at first mproving the size and quality of mutton. Dumba rams were sed with Bikaniri and Bagri ewes. The produce is good, the p are bigger and the quality of the mutton good. Colonel gan then introduced the Merino and separate experiments carried out with a view to improve the quality of the wool. Merinos were crossed with Bikaniri and Bagri ewes. There marked improvement in the quality of the wool and the quantity luced per sheep is increased. Latterly I purchased some Lohi Kali breeds of sheep from the Punjab. These are being mated the Merinos.

There is also a small flock of pure-bred Merinos. It is found the stock bred on the farm is smaller than its ancestor. The e is found to be the case in the hotter and drier belts in Australia, in consequence the bigger framed Merinos of the more perate climate have to be constantly introduced.

"NORTHERNS" COTTON.*

BY

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THE name "Northerns," as applied to cotton in Madras Presidency, is given to the indigenous cotton which is grown in the taluks of Dhone, Kurnool, Nandikotkur, Nandyal, Sirvel, Koilkuntla and Markapur in Kurnool District, the Native State of Banganapalle in the same district, Jammalamadugu and Proddatur taluks in the district of Cuddapah, and Tadpatri taluk in Anantapur District, the produce of which is brought into market at Kurnool, Nandyal, Proddatur, and Tadpatri. A small amount of cotton from the Nizam's Dominions also comes into the Kurnool market.

The crop is cultivated on both black and red soils and is always drilled. On the former soils it is usually sown in August-September with a small admixture of horse gram (*D. biflorus*), and is succeeded in the following year by *Sorghum* mixed with green gram (*P. mungo*). On the latter soils it is sown a little earlier and is usually mixed with Italian millet—two lines of millet to one of cotton. In this case also the succeeding crop is usually *Sorghum* mixed with one or more pulses.

Picking normally begins in February and continues into April. The operation is without exception done very badly. Work does not begin until about 10 A.M., when leaf, bract and boll are very dry and no care whatever is taken to try to pick the cotton clean. On the contrary, the writer has seen capsules, leaf and small branches

* A paper read at the Fifth Indian Science Congress, Lahore, 1918.

berately included in the pickings. Moreover, each cooly collects
r her pickings in one heap, which is placed on the bare ground,
eby ensuring that a certain amount of mud shall be removed
the cotton. It is therefore not to be wondered at that this
on has an unenviable reputation for dirtiness. Mill reports
that on the average the blow room loss with this cotton is
t 18 per cent.

As normally grown by the cultivator, Northerns cotton is, in the
a mixture of varieties of the two species *G. herbaceum* and
dicum. On the black soils, *herbaceum* is, as a rule, the predomi-
g species in the mixture, though sometimes *indicum* occurs to
eat an extent as 50 per cent. On red soils *indicum* is the chief
dient of the mixture, frequently to the almost entire exclusion
rbaceum. Other cottons are also found, but only to a slight
nt. These are chiefly *G. hirsutum* (Cambodia and Dharwar-
rican) and *G. neglectum* (Gogupatti—Telugu; Pulichai—Tamil).
Both of these cottons, *herbaceum* and *indicum*, have been kept
r observation at the Nandyal Agricultural Station ever since it
opened in 1906. From the experience thus gained, it is possible
lassify broadly the characters of the produce of these cottons
llows :—

	G. herbaceum	G. indicum
	3/8" to 1"	3/4" to 1"
th	Weak to strong	Strong
	White to creamy	Red
	Very harsh to soft	Fairly soft
g outturn	22 to 32%	22 to 26%
	Clean to fuzzy	Clean to fuzzy

The term "clean" is applied to seed in which the fuzz is
icted to a small tuft at each end. It has also been noticed
the types with strong lint are always more difficult to
and that types with clean seed give lint which is long, strong,
l in quantity, and, where the plant is of the *herbaceum* species,
e.

The yield of each of these species has varied according to the
on and the field on which it was grown. Comparisons, made
r experimental conditions, of the two best strains of *herbaceum*

and the best strain of *indicum* with the local mixture have gi the following results :—

	Yield per acre in lb.	
	Kapas*	Lint
Local mixture	290	72
No. 2 (herbaceum)	280	84
No. 50 Do.	330	100
No. 14 (indicum)	340	6

* Unginned cotton.

These figures are the average over the last three seasons 1914-15, 1915-16, and 1916-17.

The produce of the local crop, after being harvested, has a mo or less varied career before it reaches the buying firms, who purcha cotton for spinning purposes or for export and sale to spinner Ginning is done in Indian-owned gins either out in the district in the market town itself. These are badly managed, and, as th owners keep a sharp eye on the daily outturn, the lint is frequentl damaged and always contains a fair amount of seed, all of whic helps to make the blow room loss as great as it is. The use of a opener before ginning is a rarity, and owing to careless feedin *kapas* is frequently mixed with the lint.

Kapas produced on black soils usually gives a fairly wh lint, while the produce on red soils usually gives a distinctly r lint. The lint is therefore sold under two names—"White Northern and "Red Northerns"—the difference in price usually being b Rs. 5 to 10 in favour of the former.

Conditions of trade.

At Nandyal the trade runs on the following lines.

Parties concerned—

(1) *The producer.*

(*a*) The small ryot who, at the time of harvest, is badly in ne of money and who, therefore, cannot wait his time for selling and h to sell his produce as *kapas* and at a low rate. In this class a to be found a few ryots who have taken advances from middlem and have contracted to sell their produce at a rate agreed upo

ich is generally considerably lower than that ruling at the time en delivery is made.

(*b*) The bigger ryot who can afford to wait for his price or ave his produce ginned, and is therefore in a better position to gain then are members of class (*a*). Some members of this class village middlemen.

(2) *The village middleman.*

He buys ***kapas*** and has it ginned and is mainly responsible the mixing that is done, either because he does not take the ible to keep different qualities apart, or because he purposely es a good quality with a poor to make a larger sample which will as good or will be only slightly allowanced. The middleman on contract to the dealer and to the firms, but also sells on ready very.

(3) *The dealer.*

The dealer makes contracts on the one hand with firms to ver, and on the other hand with middlemen or ryots of class (*b*) eceive cotton of a certain quality, at a certain rate, on or before ven date. He also buys cotton and speculates on the market.

(4) *The firms.*

There are three European firms two of which own presses, one Indian firm which owns a press and a ginning factory, but h is really only a combination of dealers who sell to any of the r firms. Buying is also done by agents of other Indian firms, of Japanese firms who, however, cannot be considered regular ers.

System. The system is the pressed bale system, *i.e.*, the firms in lint and do not make final payment until the lint has been ned and pressed and weighment of the bales made. Advances given when lint is brought but cannot be pressed for some time.

Manner in which lint reaches the firms.

(1) The firms make forward contracts on the lines indicated e, chiefly with dealers to whom some firms pay brokerage, but with ryots and with middlemen. Warning is usually issued t a week before the final date on which delivery is to be made,

and, if it is asked for, an extension of time is generally given. If if delivery is not made, the firm can buy in the open market on the day on which the contract expires and charge the contractor with the difference between the contract rate at which they bought, or they can demand the difference between the contract rate and the rate prevailing on the day on which the contract expires.

(2) The ryot or middleman watches the market. When he thinks the price is high enough to suit him, he brings his cotton for sale. He leaves his cart on the roadside, while he goes round making inquiries as to what the rates are and who is likely to pay him the best price. Having decided whom he will try first, he brings his cotton into the compound and offers it for sale. It is examined and rejected, or the bargain is struck. If rejected the ryot will try elsewhere and may get a dealer to offer the cotton against one of his own contracts. The dealers who have bought on speculation also watch the market and will tender cotton which they have stored in their godowns, either against contracts, or for separate sale, whichever may be more profitable to them.

At the other markets, except for the few differences noted below, the conditions of trade are very similar.

Tadpatri. Direct dealings between producer and buying firms are practically non-existent.

Kurnool. Direct dealings between producer and firms are fairly common, and as the market is small the village middleman is much less in evidence. Buying is on the loose bale system.

Proddatur. As at Kurnool, but both systems are in vogue. When cotton is bought loose, the buyer retains the gunnies in which the cotton is packed and is entitled to make the following deductions: about $1\frac{1}{2}$ per cent. on the gross weight for dirt, and 1 per cent. on the nett weight for sample.

The quantities of cotton coming into these markets are approximately as follows:—Nandyal, 30,000; Tadpatri, 10,000; Proddatur 8,000; and Kurnool, 6,000 bales of 400 lb. each.

The above gives in broad outline the position that must be attacked if it is desired to bring about any improvement in the present state of affairs. By improvement is meant here an alteration

ich shall result on the one hand in an increased profit per acre the producer, and on the other in the buyer being offered a better ;ide.

Such improvement may follow one or more of three main lines:

(1) Improvement in the methods of cultivation, harvesting, etc;
(2) improvement in the plant itself; and
(3) improvements in the method of marketing.

Improvement in the method of cultivation, etc.

It is difficult to devise changes in the present methods of culture, nuring, harvesting and preparation of produce for sale which] bring any solid benefit to the cultivator. The seed-rate used is t excessive, and topping, thinning and growing unmixed with rse gram have not shown any advantage over the local practice.

Manuring with cattle or sheep manure, or by preceding the crop h a crop of Bengal gram, all improve the yield. The cultivator however, debarred from adopting these practices extensively owing the fact that cattle and sheep manure are to be had in only limited antities, and because Bengal gram is an uncertain and not very ofitable crop, and its introduction into the rotation would necessitate ton being grown once in three years instead of every other year at present. The practice of growing groundnuts is, however, ending rapidly, and it is likely that this crop will play the part t Bengal gram has failed to do.

With regard to harvesting, a very great improvement might be ected if the coolies were paid daily wages in grain or in money tead of a definite proportion on the day's picking as at present; and picking could be started in the early morning while the bracts l leaves are still damp with dew. This arrangement, if the kers were carefully supervised, would result in very little leaf ng picked with the cotton. Unfortunately, with Northerns cotton, king is not a gradual process, the bolls mature rapidly and evenly, l, as a rule, three pickings with an interval of about a fortnight ween each will see the harvest finished. The demand for labour these times is therefore very keen, particularly so as the cultivator

has to bear in mind that if he does not piek his erop himself, soo unauthorized person will do it for him. As labour is scarce, t piekers can more or less dietate their own terms, and as they a usually women and have to attend to household duties before goi out to work in the fields, it suits them to start late, work throu the heat of the day and return early.

They prefer to be paid a fraction of their daily pickings wages, as they ean in this way earn higher wages. This arrangeme also suits the cultivator, as he is relieved of the necessity of keepi his labourers up to the mark, and is able to get his crop harveste quickly.

It is probable that a few isolated eultivators would be able t make the change described above; but it is improbable, under preser eonditions, that they would profit by so doing.

As regards the preparation of the produee for sale, an improve ment might be brought about if the cultivator could be induced t market his crop in two qualities. This he could arrange to do eithe in the field, by having two gangs of coolies, one to pick the good well opened bolls, and the other to pick the stained and badly opene bolls, or by pieking the crop over after it has all been harveste The whole system of marketing is unfortunately against the adoptio of this practice. The writer has tried this plan more than once and has found it to result in a loss every time. When offered tw qualities like this, all the buyer does is to calculate what he would have to pay for the same total quantity at the ruling rate, and the offer a rupee or two more for the better quality and a considerably lower rate for the second quality, so that he pays a little less or at least no more than if the lot were all of one quality. The seller is left with a loss equal to or greater than the extra cost of pre paration.

Under this head, preparation for sale, defects in, or connected with, ginning must be considered. These are usually four in numbe In the first place, the mechanic who is responsible for the proper working of the plant is usually changed too frequently. For motive of economy his services are dispensed with at the end of the season until the next working season, when the same man may be employe

not as the case may be. A ginnery ordinarily pays well enough
enable the owners to retain the mechanic's services throughout
e year. It is false economy not to do so. An extension of the
orking season would obviate this difficulty. With the spread of
e groundnut crop, many gin owners are fitting up decorticators,
id are so making a more economical use of their plant.

Secondly, only a few ginneries have openers, and those who
ve do not use them properly. The main reason for this is that the
ltivator looks askance at any operation which involves the loss of
eight which the proper use of an opener undoubtedly does. A
medy which some of the firms are adopting is to offer a slightly
hanced rate for cotton known to have been ginned at a ginnery
here an opener is in use.

Thirdly, the gins are, as a rule, run too fast and, with improperly
t knives, the lint is damaged, the seed is broken and is carried
rough with the lint. The only satisfactory remedy for this at
esent is for firms which are particular on this point to buy *kapas*
id do their own ginning.

Lastly, the godown accommodation at these ginneries is exceed-
gly limited, and every year much lint is spoilt owing to the *kapas*
aving been exposed to rain and ginned while still damp. The only
medy for this is to compel gin owners to provide sufficient
odown accommodation for the produce brought to them for
inning.

Improvement of the plant.

In attacking this problem, the object to be aimed at is the
roduction of a cotton which will meet the requirements of (1) the
yot who sells his produce as *kapas*, (2) the ryot who sells as lint.
nd (3) the final buyer. The wishes of the first two parties are
asily diagnosed : neither care very much what the quality of the
otton is, provided that it is readily saleable ; both wish a heavy
ield of *kapas* per acre, and the second wishes a high ginning outturn
n addition. It is when considering the requirements of the third
arty that puzzling features arise. A careful study of the market
lrives the observer to the inevitable conclusion that class, *i.e.*,

colour and cleanliness, is of more importance than quality, i.e. length and strength of staple. Evidence of this is to be found in the difference in price between Red Northerns and White Northerns, the former of which is lower in class because of its red colour, but better in quality. A cotton, however, which combined in itself high yield of *kapas*, high ginning outturn, good class and high quality would satisfy everyone and would attract more buyers. With the object of finding such a cotton the work at Nandyal has been carried on.

The method adopted in doing this work is as follows:—

Seed of the local mixture is obtained from a cultivator and is sown on a separate plot. When the crop is in flower it is examined and a number of the most prolific plants are marked. As many flowers as possible on each of these plants are selfed. This is very simply done by sewing up the apex of the unopened corolla the evening before, or on the morning of the day on which the flower would naturally open. The produce of each plant is then collected separately, the *kapas* from selfed and unselfed bolls being kept apart. This is examined both as *kapas* and after ginning, and the best plants are kept for further examination. Next season the seed of these single plants is sown in small plots, giving a spacing of 2′ each way for each plant, so that it may have full opportunity to develop and show its type of habit. These plots are then watched to see if each strain is pure, and as many flowers as possible in each are selfed. If any of the strains are impure, selection is made as in the beginning. The produce of the pure lots is again examined, and a further weeding out takes place. In the third year there is usually enough seed of the final selections to make a comparative test and to sow a plot to give seed for next year's sowings. The comparative test is made by sowing three lines (long enough to make a plot of 4 cents) of each strain in succession, and repeating the series five times. The seed plots are sown as far from one another and other cottons as possible, and picking for seed purposes is done from the middle of the plot only. The comparative test is carried on for at least four years, and as soon as enough seed is obtained the selections are sown on a large enough area to give sufficient lint for a spinning test to be made.

The defects that have occurred in this system are inability to deal with anything but a limited number of selections, and the omission of hybridization. Either because of this, or because the ideal plant described above exists only in the imagination, the fact remains that the results obtained have not been very satisfactory. It has been possible to get three out of the four good qualities required combined in one plant, but not all four. For example, No. 50 combines high yield, high ginning outturn, and good class, but poor quality; and No. 14, high yield, good quality, and good class, but low ginning outturn. The problem is big enough and important enough to occupy fully the energies of one man.

Improvement in the method of marketing.

The outstanding features of the present methods of trade are:—(1) the system of making forward contracts, (2) indirect dealings between firms and producers through the agency of middlemen and dealers, (3) direct dealings between firms and producers, (4) the pressed bale system, and (5) the loose bale system.

The forward contract system.

Buying on this system is carried on practically right throughout the season. It has this advantage, provided that the dealer is reliable and financially sound, that the buying firm is enabled to make fairly certain that whatever conditions prevail they shall have a share of the crop even before it comes into the market.

Cases, however, occur when the dealer finds that it will pay him (for the time being at any rate, whatever may be the result in the long run) to default and hold his cotton for sale at a later date.

The system has the defect that the buyer does not see what he has bought until the cotton is tendered against the contract. In theory this does not matter very much. All that the buyer has to do is to reject or heavily allowance the cotton if it is not up to the contract quality. In actual practice this cannot be done to any great extent. Any single firm which seriously adopted this attitude would find that it could not get cotton. If all the firms concerned

would agree upon what qualities they would reject and upon what allowances they would make for qualities below their standards, and at the same time would agree to pay more for qualities above their highest standard, they would get better quality. As the system works at present, not only does the standard differ from year to year as is to be expected, but it differs from time to time during the season. Cotton is, in fact, passed, rejected, heavily allowanced or lightly allowanced, as much on the need of the firm concerned for cotton, and on the ability of the seller to stand out against allowances, as on anything else. The system is, in fact, a direct encouragement to the dealer in *kapas* to mix as little as possible of a good quality with as much as possible of a poor quality in order to get a big lot of lint which will be passed with little or no allowance. This he does with great regularity. Red Northerns sells at Rs. 5 to 10 less than White Northerns. The middleman buys up *kapas* of our No. 2 cotton which is white, and mixes it with *kapas* of Red Northerns in the proportion of about 1 : 2. He sells the lot as good White Northerns.

Indirect dealings between firms and producers.

The main advantage of this method of doing business is that the firm deals with only a few men, which allows fairly sound reliable men being chosen, who contract to supply large quantities of cotton.

It has the disadvantage, however, that it places the dealers in a position which will permit them to hold up cotton and prevent a firm from getting any if they so desire.

A further disadvantage is that the dealer has not much interest in seeing that cotton tendered is of good quality, and the system lends itself to fraud. Unless a dealer tenders against a contract cotton which he has purchased outright, when he will fight tooth and nail against allowances, he has little personal interest in what happens to the cotton, so long as it is accepted by the firm. The reason for this is that if the firm accepts the cotton with an allowance, the deduction is made from the dealer's client and the dealer himself is not affected.

Direct dealings with ryots.

This method has the disadvantage that transactions for small quantities have to be entered into, and it is not always easy to get at the ryot if he happens to fail to fulfil his contract.

It has the advantages that it is easier to get at the truth about a cotton from a ryot than from a dealer, that a good connection can be built up among ryots, and that, while the ryot would gain more by the elimination of false weighments, the firm would not pay quite so high a price. With the practically total cessation of the practice of hand-ginning now, it is more difficult than formerly to get into direct communication with the ryot. The gin-owners are as a rule also dealers, and prefer to gin for their own middlemen and other dealers. Unless, therefore, a ryot is a man of some standing, he finds it difficult, if not impossible, to get his *kapas* ginned at a power gin, unless he consents to part with the lint to a dealer.

The pressed bale system.

The advantage of this system is that the firm does not pay for the cotton until it has been cleaned on the cots. There is, therefore, no risk of the firm buying sand, stone, weights, etc., at the price of cotton. It has the disadvantage that it does away partly with the benefit of doing business with dealers, as the latter are no more prepared to take the risk of buying other things than cotton than are the firms. All the small lots bought by the dealer's clients have therefore to be pressed separately, and the dealer pays on the cleaned weights just as the firm does. When this has been done the firm gets the bales, but in the meantime has had to put up with the inconvenience of baling a number of small lots instead of one large consignment. With this exception the disadvantages are on the side of the seller and his clients. Until the lint is pressed, final payment cannot be made. The ryot who has sold direct or is a dealer's client has therefore to wait about until the cotton is pressed before he can finish his business and get back to his land. He frequently has to wait for some time, which means trouble and expense to him, and it may interfere with his preparatory cultivation.

The loose bale system.

This system has the advantage over the pressed bale system in that the buyer does not need to bale a lot of small quantities separately, and the seller has not to wait until pressing is over before he can complete his business. The deduction made for dirt is calculated to cover approximately the loss which is incurred in cleaning prior to pressing. The other two features, the gunnies becoming the property of the buyer and the deduction for sample, appear to be accidental grafts on to the main system. In the first case, the practice appears to have arisen out of the desire of the ryot to have the transaction completed and done with, so that he does not need to return and recover his gunnies. No doubt the value of the gunnies was and is included in the price paid for the cotton, but the practice has had this result that in very many cases the cotton is packed in very loosely woven poor quality gunnies, which the buyer finds difficulty in getting rid of. The practice of making a deduction for the sample is one that there appears to be little justification for, and which the seller might well object to allow.

The loose bale system has the disadvantage that the buyer has to take the risk of foreign materials being added to make up weight. As, however, each man who tenders cotton is known, this trick is one which cannot in general be played more than once and results in a very handsome deduction being made next time the perpetrator brings cotton for sale. To the ryot the loose bale system appeals strongly, as he is not kept hanging about for a long time together before his business is finished.

Summary.

These then are the main features of the present system of marketing. It will be seen that the main defects are—

(1) the lack of real competition owing to the liability of a greater or less proportion of the crop being "bound" before the actual season begins, and the seller having to come to a buyer instead of all the buyers to the seller;

(2) the prevalence of mixing; and

(3) in the case of the pressed bale system, the delay in settling business.

The question has now to be considered as to whether any other stem could be substituted for the existing system.

Freer and more open competition would be gained if the sellers ought their produce to one place, where each man's lot would ve to stand comparison with his neighbour's and to which buyers uld come to make purchases. This indicates the necessity for e establishment of an open market.

Mixing can best be detected before ginning. The produce ist therefore be sold as *kapas* and by the producer. So long as re is a difference in rates, as there is at present between Red rtherns and White Northerns, and so long as the produce is bought d sold as lint, so long will the middlemen mix these two qualities gether and endeavour to sell the mixture at the higher rate. The ot must therefore be induced to bring his *kapas* into the market sale. Another reason for having cotton brought for sale in the m of *kapas* is that, until the Agricultural Department can duce a cotton with all the four good points mentioned above, will be necessary for the firms to offer higher prices for a good ality cotton, defective in yield or ginning outturn. Unless they y this cotton as *kapas* and gin it themselves, they cannot be e that they are buying a pure article, and in addition will have put up with the cotton being damaged in ginning.

With this system the ryot could either sell outright or on the dition that his seed be returned to him and he be paid on the t obtained.

In the first case his business would be completed in a day e sold the day he brought the cotton to market; and in the second would, if he had to wait at all, have to wait no longer than he es at present for ginning. He would be spared the second wait pressing.

With this question of the open market is bound up the question honest weighment. There is no doubt that there is considerable honesty over this operation. The ryot is in the habit of hand- ming a small portion of his produce in order to test the ginning

outturn. If therefore he could be sure of the weights of his *kapas* he would have a fairly shrewd idea of how much his lint ought to weigh after the *kapas* was ginned. The most feasible plan would therefore seem to be to have the *kapas* weighed publicly in the open market (probably a platform machine with a dial as used in auction marts at home would be most satisfactory) and frequent check of weights used outside the market.

Conclusions.

To sum up, the requirements for the improvement of Northern cotton are (1) more time and research to be given to the improvement of the plant, (2) better harvesting and preparation for market, (3) better ginning, (4) establishment of an open market to which cotton would be brought as *kapas*, and (5) the establishment of ginneries properly fitted and constructed, either owned or controlled by the buying firms. (1), (3), (4), and (5) are well within the bounds of possibility; (2) will require a large amount of spade work to be done by the department, backed by substantial aid from the buying firms, before any improvement along this line is likely to be brought about.

THE IMPROVEMENT OF "TINNEVELLIES" COTTON.*

BY

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THE Tinnevelly tract, with which the subject of this paper concerned, comprises the three southernmost districts of the Madras esidency. Cotton is here cultivated on an area of about 600,000 res. The tract is bounded on the north by the Periyar irrigation oject, on the east and south by the sea, and on the west by the nts. The compact and somewhat isolated position of the tract gely accounts for its individuality, for the conditions obtaining re differ in many respects from those in cotton tracts of other rts of India.

COMMERCIAL "TINNEVELLIES" COTTON.

"Tinnevellies" cotton is essentially a dry-land crop cultivated der unirrigated conditions on black soil of varying depth and tural fertility. It is, in reality, a mixture of two distinct rieties of cotton known locally as *karunganni* (*Gossypium usifolium*, Gammie), and *uppam* (*Gossypium herbaceum*). The tribution of these two varieties within the tract is of interest that *karunganni* is the more commonly cultivated in the south l *uppam* in the north. In the central parts we generally find xtures of these, but stray plants of either variety may be found almost any cotton field. Until recently it was only in very rare

* A paper read at the Fifth Indian Science Congress, Lahore, January, 1918.

cases that pure crops of either variety could be seen. The distribution of these two varieties is believed to be a natural one determined by the habitat best suited to each. The south is nearer the sea; the sea breeze blows more frequently and strongly than in the north, and the rainfall in the south is generally low and precarious.

The average crop of "Tinnies" marketed annually is about 100,000 bales of 400 lb. each. It is sown in October-November with the N.-E. monsoon rains and harvested between March and August. With favourable summer rains the crop gives a good second flush.

"Tinnies" cotton averages about ⅞ inch in length. It gives an average lint outturn of 25 per cent., and an average acre yield of about 300 lb. of seed cotton. It has a slight creamy colour and is strong. F. G. F. "Tinnies" can spin a good 25's yarn and is valued in normal times on the Liverpool Exchange at about ½*d.* per lb. below "Middling Americans."

Lines of Improvement.

The improvements effected in "Tinnies" cotton since the department first undertook the work falls under five main heads:—

Firstly, the selection of improved strains;

secondly, the propagation of the best selected strains;

thirdly, the marketing of these strains;

fourthly, the introduction of drill cultivation, and the manufacture and sale of drill-sowing and interculturing implements; and

fifthly, the eradication from the "Tinny" tract of a low grade cotton of the "neglectum" type, known locally as "pulichai."

The last two subjects are of sufficient importance to demand separate chapters, and this paper will mostly be confined to the work done up to the end of the 1917 season on the selection, propagation, and marketing of unit strain selections of cotton in the "Tinny" tract.

System of selection.

The selection work is done entirely at the Koilpatti Agricul- l Station, and though the system adopted claims no pretence to g highly scientific yet it serves a useful purpose, as evidenced the ends attained. The *modus operandi* may be of interest those engaged on similar work elsewhere.

In 1908, Mr. Sampson, who was then in charge of the work, r examining a large number of plants, decided to confine selection k to two main types of *karunganni* as this species had proved be much more variable in a number of characters than the *pam* species. One of his types was small, bushy, early flowering, possessing a large number of vegetative branches. Another tall, late maturing, and bearing mostly fruiting branches. e then, and up to the 1917 season, the produce of a large number plants from these two main types bearing superior characters e each year been bagged separately in the field. A small bag ied round the neck of the selected plant, and both the bag its contents are left in position until the end of the main king season.

The examination of the seed cotton from these single plant ections involves the scrutiny of a number of characters, amongst ich are included--

length of staple,
strength of staple,
ginning outturn,
fineness,
whiteness,
silkiness,
and uniformity of staple.

re recently the yield of seed cotton per plant has been given ater consideration than formerly. Only those plants are retained propagated which show all-round excellence.

In the course of these investigations plants have been dis- ered with a ginning outturn as high as 36 per cent. against an rage of 25 per cent. for "Tinnies," and others having a staple

of $1\frac{1}{4}$ inches as compared with an average of $\frac{7}{8}$ inch for Tinnie
The available evidence seems to point to the fact that in seed cot
excellence in length of staple and in ginning outturn are to
certain degree mutually antagonistic. Very few unit strains ha
been discovered which combine these characters. The selec
strain having a staple of $1\frac{1}{4}$ inches had a ginning outturn of 25
cent. only; and the strain which ginned at 36 per cent. had
relatively short and coarse staple. It naturally follows, then, th
of the 500 odd plants selected each year a very large proporti
has to be discarded.

Having survived this preliminary test the question of pr
pagation arises. The single plant selections which do surv
(generally about 50 in number) are in the second year grown co
paratively in three-line contiguous comparative plots, each bear
about 75 plants. Those which do not breed true to type, or wh
are in other respects inferior, are at this stage discarded. He
again, as at all subsequent stages, the comparative yield of l
per unit area is given due consideration. The best "three-lin
selections are propagated on to the "field-plot" scale of 5 cen
in the third year when they are again tested against each other, a
on to the "field-crop" scale of one acre in the fourth year. By th
time only some two or three selections remain. In the sixth ye
these are grown on contract by ryots in the usual ryotwari manne
except that they are drill-sown. The seed cotton is purchase
by the department at special rates, is ginned at the Koilpat
farm, and tested in the local spinning mills. The best strain
then propagated in the seventh year on the maximum scale of abo
400 acres under "seed-farm" conditions on contract by ryo
The seed cotton from the whole of this area is again purchase
and ginned by the department, and the seed sold to the public
Even then, in its eighth year, a unit strain selection cannot b
grown on a sufficiently large area to command the attention o
exporting firms, as distinguished from local spinners. In the nint
year the outlook is materially changed, for the unit strain can the
be grown on an area exceeding 10,000 acres, and the produce ca
be marketed and shipped in bulk.

"COMPANY" COTTON.

Such, in brief, is the outline of the history of the unit strain
tions now being marketed on a commercial scale as "Company 2"
"Company 3" (or as "Karunganni 2" and "Karunganni 3,"
some firms prefer to call them). The former first arrived
his stage in 1915, and the latter in 1916. This stage is, perhaps,
most critical in the history of any unit strain selection. Up to
time exporters would offer no premium for this cotton and
produce was sold to the local spinning mills at a nominal
mium which rose steadily from Rs. 3 per *candy* of 500 lb. in
3 to Rs. 7 in 1915. We feel our indebtedness to these mills
the support thus given, without which the progress of the
k would have been seriously handicapped. This experience
be of use to those engaged in similar work in making arrange-
ts for marketing selected cotton, when available in small lots
to local spinners rather than to exporters. When such cotton
mes available in thousands of bales the premium offered will
st itself commensurate with the intrinsic value of the cotton.
orters become interested and competition follows.

MARKETING.

At the commencement of the 1916 season a circular letter
issued to all the local cotton firms intimating them that there
ld be on the market that year some 1,600 *candies* (of 500 lb.)
"Company 2," and 400 *candies* of "Company 3." Samples
oth types were sent to each firm. They were further informed
the department could arrange the delivery of the major portion
hese cottons in a pure form. On the strength of this guarantee
miums were offered by practically all the local firms. These
miums varied from Rs. 4 to Rs. 10 per *candy* of lint, in excess of
ruling market price of "Timnies" on the date of delivery or of
tract.

Cotton improvement in Tinnevelly has the Koilpatti Agri-
ural Station as its nucleus. The Farm Manager, in addition
is more legitimate duties on the farm, is responsible for the
eral supervision of district work throughout the tract which is

divided into four circles each in charge of an Agricultural Demon trator. When offers of premiums were received by me from th cotton firms early in 1915, these were immediately communicate to the Circle Demonstrators. They, in their turn, conveyed th happy news to those ryots who had grown "Company" cotto The ryot is left to decide for himself as to which firm he will ta his cotton—but he is no such fool as not to take it to the highe bidder. This led to an interesting development. Many of the fir were anxious to procure sample consignments of these cottons. least in sufficient quantity to place them on the Indian and foreign markets where "Tinnies" are commonly used. Competition led t over-bidding, and the 1916 season closed with a premium of Rs. 1 per *candy* being offered for unlimited quantities. The competitio was so keen that I received open offers from more than one firm of a premium of one rupee in excess of what any other firm was prepared to give. This made my position impossible. Needless to say such offers were discountenanced, and only offers of specific pre miums expressed in rupees were communicated to the Demonstrators I here desire to emphasize the fact, and to make it absolutely clear that at no stage has there been any hankering whatsoever fo enhanced premiums. Subsequent to the issue of the origina circular letter already referred to, no firm was invited to rais its premium, neither was it informed what premium was bein paid by any other firm. All offers of premiums, subsequent t those first communicated in reply to my circular, were unsolicite

I have dwelt at some length on this topic because in a ma where the competition is already keen it is so easy to give offen to or clash with the interests of cotton firms in such a manr that they may refuse to continue to give their support to cott improvement work, without which it would be extremely difficult for the department to continue its efforts.

Now of the 2,000 *candies* of lint of what has been designated "Company" cotton, reported to the various firms to be available in 1915, only some 120 *candies* were grown on contract by ryots for the department for propagation purposes. Registers had however, been maintained noting the names of those ryots to whom

ed had been distributed at the time of sowing. It was incumbent on the department, therefore, to devise some means of ensuring e delivery direct to the firms of "Company" cotton grown ivately by ryots. With this end in view a system of certificates as instituted whereby the purity of the seed cotton was guaranteed. hese certificates guarantee the purity of the seed cotton delivered. hey ensure that the ryot will receive the maximum premium for s produce. They further ensure that, as long as the cotton is ailable in sufficient bulk, it will be brought to the notice of foreign arkets in its pure state—at least, I should say, by those firms ho would prefer not to use it for grading up inferior quality Tinnies." Other useful purposes which these certificates incidentally serve will be alluded to later.

This last year, 1917, the quantity of "Company" cotton on the arket was estimated at about 12,000 *candies* of 500 lb. The eater portion of this has naturally been delivered to those firms hich were most anxious to procure it, that is, those which paid ie highest premium. Agents of other firms tell me that a emium of Rs. 16 per *candy* is inflated and does not truly represent ie intrinsic value of this cotton. For, they say, at present rates, is premium involves an aggregate cost exceeding that paid for iddling Americans. I have been informed on the authority f the agent of an Indian cotton mill who has experience of this otton that by using it for the usual "Tinnies" counts of 25's arn there is a saving of 10 per cent. in mill production attributed o the regularity of staple and cleanliness. It so happens that this aving, in itself, more than compensates the mill-owner for the remium of Rs. 16, apart altogether from the enhanced value f the cotton due to its higher spinning qualities. In 1917 the remium paid has varied from Rs. 10 to Rs. 15 per *candy* of 500 lb. f lint. This slightly decreased premium is to be attributed chiefly o the receipt of unseasonal rains which were adverse to the whole "Tinny" crop, not excluding "Company" cotton. The latter was not so conspicuously clean as in 1916. And cleanliness and whiteness, unfortunately, take precedence with some exporters ver quality of staple.

Average samples of the 1917 "Company" crop were again tested for their spinning qualities, and it is pleasing to note that they have maintained their high standard of 40's counts.

It remains to be seen how the premium offered for "Company" cotton will fluctuate in the future. But I have a shrewd idea that, before many summers have passed, "Company" cotton will be grown on such a scale that it may be purchased at just a nominal premium, if any, even when certified to be pure. There have been many instances in the past season where "Company" cotton has been delivered to firms unaccompanied by certificate and no premium paid for it. I have in mind one outstanding case where an exporting firm submitted for valuation to arbitrators in the Liverpool Cotton Exchange samples of—

	Rs.	
(*a*) "Ordinary Tinnies," which was valued at	189	per *candy* of 500 lb. of lint.
(*b*) "Good Average Tinnies" which was valued at ..	197½	
(*c*) "Company 2" (certified) .. .. ,, ,, ..	197½	
(*d*) "Company 3" (certified) .. ,, ,, ,, ..	199	

The astonishing part about these valuations is that "Company 2" was valued at the same price as "Good Average Tinnies." This was of special interest and certainly demanded further investigation. The origin of the "Good Average Tinnies" was enquired into, and it was discovered that a large proportion of the cotton delivered as such by the dealers at the ginning factory was uncertified "Company 2" grown from seed sold to the public in the previous season.

Cultivator's profits.

In order to reap maximum profits the ryot who grows "Company" cotton relies on three separate factors, namely, the superior quality of the lint, the high ginning percentage of the seed cotton, and on the premium which the seed commands. The average acre yield of seed cotton is only slightly higher in the case of "Company" cotton than in ordinary "Tinnies."

Firstly, then, an average premium of Rs. 12 per *candy* of 500 lb. means an additional profit of Rs. 2 per acre.

Secondly, cotton giving an average ginning outturn of 32 r cent., as compared with 25 per cent. for "Tinnies," means an ldition profit of Rs. 9 per acre. It is this factor—a high ginning rcentage—that will make it profitable to the ryot to grow Company" cotton in the absence of any premium. This further plains why middlemen find it profitable to pay him a premium high as Rs. 3 per *pothie* of 250 pounds for seed cotton of Company 2" ginning at 28–29 per cent., and Rs. 5–6 for Company 3" ginning at 31 to 33 per cent. At this price the iddleman still makes a profit even when he receives no premium r the superior quality of the lint, for certificates guaranteeing urity are issued to actual cultivators only.

Thirdly, there is a demand at present for "Company" seed at premium, and this means an additional profit averaging about s. 4 per acre.

This makes an aggregate net profit of Rs. 15 per acre in a ormal season, in excess, I may point out, of the profits that could e made by growing ordinary "Tinnies." These large profits ere made by the relatively few who grew "Company" cotton n 1916, and this served in 1917 as an excellent advertisement. 'he demand had become so great in 1917 preparatory for the 918 crop that the seed available was quite inadequate to meet he demand. The 1917 crop of "Company" cotton was estimated t about 70,000 acres.

Co-operative sales.

It has now been made sufficiently clear that Mr. Sampson has uccceded in turning out high grade varieties of cotton which can e profitably grown on the local black soil, and which are superior o anything the ryot had hitherto at his command. It still rested vith the department to organize—

(*a*) a system by which these cottons could be marketed in an unadulterated form to the mills on a wholesale scale; and

(*b*) a system by which any unit strain could be propagated on the maximum scale in as short a time as possible.

A branch of work which has received much attention for t
past four or five years is the co-operative sale of cotton by t
cultivators direct to the firms. Incidentally, the success that h
attended this branch of work has been the keystone to the success
propagation of "Company" cotton and its being marketed i
the greater part in an uncontaminated form.

The system of co-operative sale of cotton as instituted in t
Tinnevelly tract is in practice a simple operation, but many difficulti
which impede the progress of the work have to be encountere
Broadly speaking, the ryots of a village, or of adjoining villages, a
induced to pool their seed cotton and deliver it in bulk as on
consignment direct to the ginnery. When this can be done, each firm
has expressed its readiness to clean out its gins previously so as t
avoid accidental missing of seed in the gins. Payment is made
by the firm for the lint on the day of delivery to one of the co
operators who acts as spokesman to the party. He divides on
the spot amongst his fellow co-operators both the proceeds and the
seed obtained in direct proportion to the quantity of seed cotton
delivered by each. As is the local system, each ryot takes back
his seed to the village or sells it locally to a seedsman. The cotton
firms here deal in lint only. All the details of the transac-
tion are left to the co-operators; and up to the present not a
single case has been reported to me where there has been any
serious difference of opinion in regard to payments made
etc.

System of certifying purity.

The progress of this co-operative effort has been accelerated
by the fact that in 1916 there was on the market a fair quantity
of "Company" cotton for which a premium was offered by the
firms conditional to its being marketed in a pure form. An attempt
was made to effect this end by promising to every grower of
"Company" cotton one of the certificates already alluded to
guaranteeing the purity of his produce. But a condition was
imposed that a certificate would only be issued if he agreed to
sell his cotton co-operatively with his neighbours.

I have previously referred to the use that is being made of ese certificates. I will endeavour further to explain some of the eful purposes which they have been found to serve.

There are two certificates—A and B—issued on differently loured strong paper. Certificate "A" bears the name of the ryot ho has grown "Company" cotton, his father's name (for identi-ation purposes), the total area under cotton cultivated by him, e area under "Company" cotton, the quantity of seed cotton eviously ginned co-operatively in the current season, the quantity w ginned, the value received for his cotton, and the market rate "Tinnies" on the date of sale. This certificate is issued to the ot by the Circle Demonstrator who knows him personally and has spected his standing crop. The Demonstrator signs and dates it, d the ryot, on delivery of his cotton, hands it over to the mill ent. The latter endorses it and posts it to the Deputy Director of griculture for registration and check purposes. Certificate "B" nsolidates all the "A" certificates brought in by a number of ots when they deliver their goods. Ryots now realize that these its are often worth considerably more than their weight in gold, d a check on their issue has been found necessary. They are mbered consecutively and the unused balance remaining at e end of the season is destroyed.

This system of certifying the purity of cotton was originally troduced with the primary idea of meeting and checking attempts adulterating "Company" cotton, for reports from other provinces dicated that wilful adulteration had been there a formidable ar to the progress of cotton improvement work. When a ryot caught in an attempt to deliver under certificate adulterated Company" cotton, that certificate is forthwith cancelled, no remium is paid for his cotton, he is blackballed for the ensuing eason, and those who co-operated with him are penalized for ermitting him to take such liberties.

These certificates, then, have not only fulfilled the purpose r which they were originally designed, but they have done much ore. Yet the scale on which it will be possible to distribute hem in the future will always be strictly limited as long as we

continue the practice of issuing them to individual ryots. The staff at the disposal of the department could never cope with the work involved by such a wholesale distribution of certificates because it is the duty of the Demonstrator to inspect both the standing crop and the cotton marketed, and to satisfy himself before issuing the certificate that each of these is pure. This system of certifying the purity of cotton, though it has served our immediate purpose, has its weakness.

Village seed-unions.

This brings us to the question of village seed-unions. These are a recent development of the system of co-operative sale of cotton originally instituted by Mr. Sampson. I have, personally, pinned my faith all along to these seed-unions as being the keystone to the successful continuance of improvement work with "Tinnies" cotton. The necessity for organized effort to control the supply of selected seed was first seriously felt in 1915. So in 1916 six seed-unions were organized, on a tentative basis, in those villages where improvement work was most advanced. In two of these villages Agricultural Co-operative Societies already existed. Ryots who had pooled their seed cotton and had sold the lint co-operatively were induced to go one stage further and pool their seed for sale purposes. This had to be stored until the sowing season approached and then sold to the public at a premium. Here the same difficulty arose as had been previously experienced with the co-operative sale of cotton. The Tinnevelly ryot is generally a small tenant farmer and lives a hand-to-mouth existence. If he defers the sale of his produce he may increase his indebtedness, due to interest on loans, out of all proportion to the additional profits made by holding up his goods. The obvious solution to this contingency is to form co-operative societies through which the ryot may obtain advances on his stock at reasonable rates. The Co-operative Societies Department has given us much assistance in this direction. Up to the present some 12 seed-unions have been formed. Experience was gained with those first formed in 1916 to avoid pitfalls in extending the work in 1917.

Before a seed-union is now organized in any village the way is first paved by the Circle Demonstrator for the formation of a co-operative society. The co-operative officers concerned are then invited to enquire into the feasibility of forming a co-operative credit society in that village. If this can be done a seed-union follows with a suitable constitution and by-laws. The members can, if they so desire, then borrow money from the urban bank through the co-operative society.

Seed-unions are located in such a manner as not to interfere with each other's sales. They made such profits from the sale of seed from the 1916 crop that in 1917 numerous petitions were received from village panchayats to form similar unions. "Company" seed sold at prices varying from Rs. 12 to Rs. 24 per *pothie* of 250 lb., as compared with Rs. 8 to Rs. 10 for bazaar seed.

Seed-unions now form the chief agency for distributing improved seed. Each seed-union has its own seed farm approximating in area to one-twentieth of the area grown under cotton by all the union members. Each year the department supplies the union with ample seed to cultivate this proportionate area in each seed-union village. The seed from this area is retained for their own use by the members in the following year. In the next year there is ample seed available with the union to supply to the public; but the union carries on with its own seed farm each year.

Such a system, when perfected and widely organized throughout the tract, will further be invaluable in hastening the propagation of any unit strain selection that may be found superior to those already marketed. Thus, seeing that a unit strain can be grown on an area of 20 acres after six years' propagation and preliminary testing, then assuming that it will yield twenty-fold we can—

the 7th	year	be grown	on	400 acres of seed farm,
the 8th	"	"	"	8,000 acres of union seed farm,
the 9th	"	"	"	160,000 acres of union lands, and
the 10th	"	"	"	3,200,000 acres sown from seed sold to the public from seed unions.

But the Tinnevelly tract only comprises an acreage of about 600,000. Hence allowing for an appreciable loss of seed each year for use as cattle-food, it should be possible in actual practice for any unit strain to be propagated under this system over the major portion of the tract within 10 years. This is, of course, assuming that such a unit strain would surpass anything previously placed on the market. For this purpose, it would be necessary, in theory, to organize and control not more than 75 seed-unions, each running its own seed farm averaging about 30 acres. This, I claim, is not beyond the possibilities of practical politics, but in practice numerous difficulties have to be encountered which, though they retard the rate of progress, have not been found to be insurmountable.

Departmental seed farms.

Until the necessary seed-unions have been fully established it will be incumbent upon the department to continue its present practice of growing unit strains on contract on a much larger area than the theoretical 100 acres. Up to 1916 the average area under contract seed farms was about 500 acres. In that year special arrangements had to be made to increase the area in order to meet the "pulichai" situation. The area under ordinary contract seed farms, whereby the department purchased the seed cotton, was reduced by one half, and an area exceeding 2,000 acres was grown on contract whereby the department purchased and handled the seed only. This work, I may say, was done on the financial allotment originally made by the Government to contract for 500 acres of seed farms. Under neither system of seed farms does the Government stand to lose anything by the transaction. In spite of the premiums given by the department to contracting ryots this work is being run at a slight profit as the lint always fetches the best market-price obtainable and the seed is sold at enhanced rates for sowing. All the departmental seed grown on contract in 1917 (apart from the stock held by the seed-unions) found a ready market at 50 per cent. above the price of local seed. The demand was considerably in excess of the supply.

ADULTERATION AND "PULCHAI" ERADICATION.

The improvement of "Tinnevellies" cotton is vitally con-
ued with the maintenance of purity. And as "pulichai" eradi-
ion has been given precedence for the past two seasons over all
er work, it deserves at least a passing reference.

Adulteration—that insidious and cankerous disease to which
many branches of Indian trade evince a predisposition—at
e time threatened not only to impede the progress of cotton
provement work in Tinnevelly, but, had it not been checked,
uld probably have in course of time reduced the value of "Tinnies"
that of "Bengals."

The adulterant in Tinnevelly is locally known as "pulichai,"
ng a variety of *Gossypium neglectum*. It is a recent intruder
o the Tinnevelly tract, and was first noticed in an appreciable
antity some eight years ago. The local firms, on their own
tiative, attempted in concert in 1910 to stamp out this weed, but
th little success. In 1915 the situation had become so serious
t foreign markets complained of the tendency of "Tinnies" staple
deteriorate and they allowanced accordingly. Action was then
en by the Agricultural Department in co-operation with all
local firms, and with the revenue authorities. I am glad to
able to record that with this united effort the area under pure
ulichai" was reduced from at least 1,000 acres in 1915 to
out 90 acres in 1917, with about ten times this area under
ulichai" mixtures in which the "pulichai" did not exceed
per cent. of the crop. The produce from the whole of the 1917
pulichai" crop was bought by the Government at 25 per cent.
low market rates for "Tinnies," which price represented
intrinsic value as "Bengals." The seed derived therefrom
as publicly burnt to prevent further propagation. I have
firm belief that there will be very little, if any, pure "pulichai"
ltivated this year. But there will naturally be accidental mix-
res; and the cotton firms, in view of the success that has already
tended these efforts, have decided to continue their share of the
ork but with increased penalties for any "pulichai" received in
liveries against "Tinnevellies" contracts. Those interested in

this work will find further details in the Annual Reports of t Madras Agricultural Department for the years 1915-16 and 1916-

I have here made special reference to this latter branch of wo because its success is intimately associated with the fact that at t crisis in 1915-16 we had at hand in one of Mr. Sampson's unit stra selections, namely, "Company 3," a cotton which could oust "pu chai" at its own game as far as ginning percentage was concerne Whereas for spinning quality it can spin good 40's yarn as compare with 12's for "Bengals" of the *neglectum* type. We claim to hav saved "Tinnies" from the fate that has befallen medium staple cottons in other parts of India, and if legislation can be introduced at this stage making it a penal offence both to grow and to ga "pulichai" cotton, then the high position held by "Tinnies" on the world's cotton markets will not only be saved but will l secured.

In regard to district work generally, I may add that no sma part of the success that has been attained is to be attributed to th college-trained subordinate staff who, though new to much of th work, have far exceeded my expectations. The work demanded degree of tact, resourcefulness, and industriousness on their pa of no mean order. And as long as our Agricultural Colleges ca turn out men of this calibre it will always be a pride and pleasure to work with them.

THE CONSOLIDATION OF AGRICULTURAL HOLDINGS IN THE UNITED PROVINCES.

BY

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(Concluded from page 64, vol. XIV, pt. I.)

PART II. OUTLINE OF PROPOSED CHANGES—(*concld.*).

TYPES OF NEW VILLAGES.

IN the first place it is necessary to get a clear idea of the kind of lage we wish to facilitate the growth of. In the neighbourhood Allahabad the size of the administrative villages varies very nsiderably, from 200 acres or so up to about 3,000 acres. The gest villages are disliked owing to the excessive complication the accounts, and the need of employing two or three patwaris llage accountants). On the other hand the small villages cannot pport a single patwari, and one man acts for two, three or even r villages. Some administrative villages are without any abited site at all, the owners having migrated and the land ing let or sold to inhabitants of surrounding villages who walk ance to cultivate their fields. For revenue and other administra- e purposes, as well as for our purpose of consolidating holdings, will be desirable to adopt a policy of freedom in altering, and rticularly in enlarging, village boundaries, so as to produce mpact villages varying from 2,000 acres up to 3,500 acres.

As such villages will often embrace four or five existing villag there will be four or five *abadis*, as may be found in some villag now. In the Punjab where rainfall is slight the choice of *abadi* lies between several squares in an administrative *chak*; l where the monsoon rainfall (June to September) exceeds 20 inch dwelling sites must be chosen with care; and there are not ma to be found which will be dry in a wet monsoon and yet conveniently located for water-supply and other purposes. T question of dwelling sites is much too complicated to be settled external authority, and I think it was a pity that Mr. Moreland his note raised the question of villagers migrating to live on th holdings, as the replies of a large proportion of the zemindars whom the note was circulated are in opposition to the consolidati of holdings on the ground that the cultivators will refuse to lea their *abadis* and go to live on their holdings. The two questio are really entirely distinct, and should be kept so. The experien of thousands of square miles of the canal colonies shows that it perfectly possible to have compact holdings lying at vary distances from the *abadi* in which all villagers live. A large *ab* there becomes almost a little town, with properly planned stre and several shops, a school, and open market square.

If the cultivators ultimately find that the agricultural advanta of living on their holdings outweighs its social and oth disadvantages, they will move out of their own accord, provid legal facility is given for them to obtain consent to build and al compensation for such improvement if ejected. If this protection granted, the question may be left, I think, to settle itself. Faciliti should also be arranged where desired for gradually rebuildi existing *abadis* on their present sites, so as to provide more spa wide roads, and better sanitary conditions in every way.

The arrangement of the fields, when a new allotment is mad should have reference not only to the requirements of agricultu but also to the convenience of the revenue and land record officia and also of the Irrigation Department in districts watered by cana In my opinion no account should be taken of the existing fie boundaries. A clean sweep should be made and redistributi

l out on the simplest possible plan. There is no doubt that ectangular field system, adopted in the Punjab colonies, has as in America, very great advantages. Whether the fields be lly made squares or rectangles all field measurements are y simplified, and water is saved in irrigation. A further tage is that boundary stones cannot be shifted without detec- since the observer should always see in each direction long lines ts at equal distances in a straight line. It does not seem to me ary to insist on the new compact holdings being fenced in, wners or occupiers should be at liberty to put up boundary , of which not less than half the thickness must be on their and.* Fencing with mud or kachcha brick walls, or wire, l be encouraged, and hedges discouraged, except perhaps for ing pasture.

s regards the latter, the allotment would always provide g ground close to the *abadi*, and usually this would be split o fields of about two or three acres in size so that each culti- could have a paddock for his cattle. An alternative plan be to have the grazing land immediately around the village ip into two or three large enclosed fields of from 20 up to 40 each, in each of which certain villagers would have specified g rights. Each house would also have a small yard of one- or even only one-eighth of an acre immediately beside the . Any stretch of waste land lying at a distance from the could also be reserved as a pasture ground and be enclosed a ring fence so that cattle could be left there safely enough g daylight without children posted to watch, and in some perhaps at night. It must be remembered that one result rural reorganization should be to bring a school to every e, where a curriculum having a definite relation to the pal occupation would be taught; consequently the cheap r of children would not be available for watching cattle, hey must be prevented by fences from straying into the corn-

* The projection over the neighbour's land should be limited to 12 inches.

Enlargement of holdings.

In the first part of this paper I have already indicated reasons for wishing to see a considerable increase in the average of holdings cultivated, in order that a higher standard of living m be introduced and have the opportunity of perpetuating its The actual size of holdings should vary considerably. It is alw a false ideal to aim at uniformity where the natural conditions utilization and of social evolution demand variety. In the f place, the size of holdings must vary according to the character fertility of the soil and the nature of the farming for which climate and distance from market render it suitable. In the sec place, different cultivators differ very much as regards the area which they have sufficient capital or sufficient managing abili I have come across cases within no great distance from Allahal where men are said to be farming as much as 200 to 300 acres, so of which they own, but most of which is rented in a multitude small fields.* Such men must have considerable managing abilit and if they could get compact areas of 300 acres or so, they wo probably be ready to learn improved methods and introduce labo saving machinery.

It would appear that in the central parts of the Ganges pla outside the canal irrigated area, the mode about which the holdi of cultivators wholly or mainly dependent on agriculture for th livelihood vary in size is about 8 or 9 acres.†

It is not easy to get actual statistics of areas cultivated ow to the fragmentation of the fields, and to the fact that the rent of fields in an adjoining village as a sub-tenant is a not uncomm practice. It is impossible to trace such cross-lettings except by close analysis of the patwari's registers (*khatauni-jamabandi*) of large group of conterminous villages, or by personal enquiries the spot. A classification of the holdings of one village conside

* This is hearsay evidence gathered in the villages and requires confirmation by de inquiries. The largest figure mentioned was 600 bighas, and possibly much of it is worke the share system.

† The *mode* is defined by statisticians as the most frequently occurring number or va any series, or "the number of which most instances can be found."—(Bowley. *Elements Statistics*, p. 123.)

be very probably typical of the dry area of the Lower Doab is given in the following table :—

Sizes of groups	Number in each group	Number in half-acre groups
Acre and under*	48	26
1 acres and over	41	22
2 " "	21	28
3 " "	17	13
4 " "	11	14
5 " "	9	7
6 " "	2	7
7 " "	8	10
8 " "	4	6
9 " "	1	5
10 " "	3	
11 " "	1	
12 " "	3	
13 " "	1	
14 " "	0	
15 " "	0	
16 " "	1	
Over 17 acres :—		
38·4 acres	1	
49·5 "	1	

* The original figures are given in bighas, biswas (20=1 bigha), and biswansis (20=1 biswa) have been converted at the rate of 32 biswas=1 acre.

These figures are plotted in the following graph, which shows that the mode is approximately one acre :—

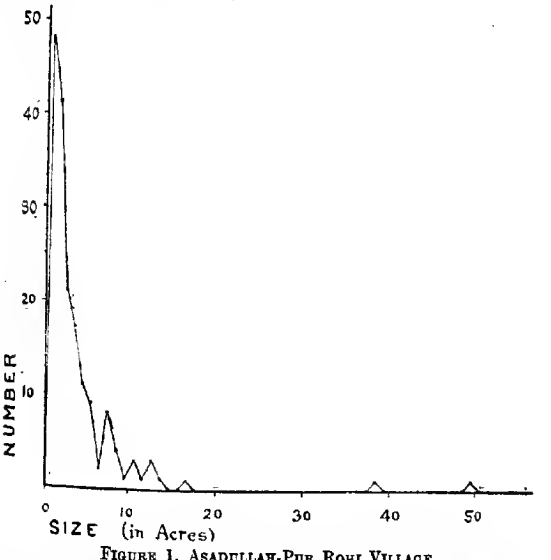

FIGURE 1. ASADULLAH-PUR ROHI VILLAGE.

The ordinates (distances measured vertically from the base line) represent the numbers of cultivation holdings (farms) in each one-acre group; and the abscissæ represent the size of the area groups in acres. The groups are defined as in the above table.

Taking all matters into consideration, it appears to me tha proper arrangement of the size of holdings, in accordance with principles which have been outlined in the earlier part of this pap would produce a graph of the shape shown by the continuous l in figure 2 below. The size distribution which seems now to pre is indicated by the broken line.

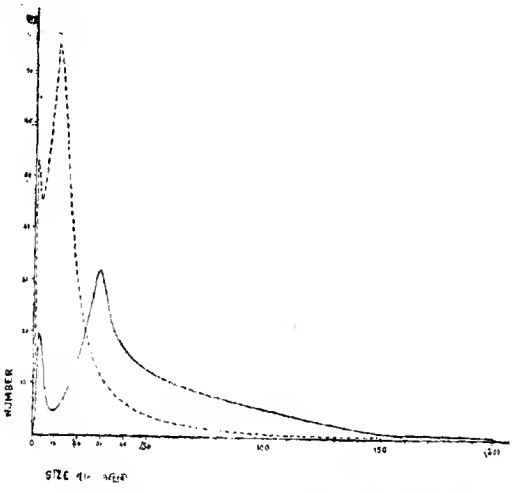

FIGURE 2. HYPOTHETICAL EXAMPLE.

The broken line is intended to illustrate the present size distribution of the ordi cultivation holdings in a tahsil or district; and the continuous line represents the s distribution which is here advocated as desirable when reorganization of holdings is undertak

In both of the curves we see two peaks, corresponding to tw distinct modes. Examining the curve representing the propos rearrangement and enlargement of holdings we find that the lo and lower mode occurs at a size of between two and three acre whilst the other, or greater mode, occurs at about 29 or 30 acr This curve would be interpreted to mean that there are in th group of villages represented farms of all sizes from two acres t to 200 acres, but that there is a considerable number of small holdin cultivated of about $2\frac{1}{2}$ and 3 acres in size, several of four acres, an a few of six, seven, eight or nine acres. There are rather more 10 acres, and a few more of 11 or 12 acres; and for each successi

greater number is to be found up to the size of 29 acres, after ch the number of farms in each acre group declines pretty idly at first and then slowly, meaning that there are a dozen ns or so of each size up to 50 or 60 acres and a few much larger ns up to 200 acres. I am here using the word "farm" in the se of cultivating unit. The very small ones of two up to five s in size would be small holdings cultivated by artisans and ners having some other occupation as their principal means of lihood. Farms above 40 acres would mainly be cultivated by ons of special intelligence and aptitude or of considerable acity, in many cases trained, we may hope, by one of the agri- ural colleges.

The advantage of having such variety in the size of holdings at, in the first place, it gives scope to enterprising cultivators may be able without going to another district to move from a ll to a considerably larger farm. In the second place, it tends ntroduce variety in the methods of cultivation in any district. sequently such of the larger farmers as are progressive and have icient capital will be a good example to those who for the time e only small holdings. Another important point is to introduce ibility in the size of holdings so that cultivators may easily add the area which they are farming when neighbouring land falls ant. The rectangular field system as laid out in the Lower Bari ab Colony would seem to lend itself excellently to this, as the ares are subdivided each into 25 fields of exactly one acre, which numbered uniformly throughout the whole colony according to officially established system.

Removal of surplus population.

The average size of holdings which I have indicated as desirable e adopted as the mode is rather more than three times the mode the existing cultivating unit. If the sole change were in the rease of the size of the holdings, it would simply mean that after redistribution the land was to be rented to those of the previous tivators who could best manage larger areas, and that the others uld continue to reside in the villages, working on the farms as

labourers. It is an express object of the proposed policy of increasing the size of holdings thereby to create an opportunity for the introduction of better methods of cultivation; consequently so far as capital becomes available for employing labour-saving machinery there must be a displacement of hired agricultural labour. By the opening of better communication with railway stations, which should be a integral part of the scheme, there will not only be a rise in the value of farms and of the articles produced at the farms, but also increased competition of factory-made goods brought from outside to the villages, which would tend still further to kill the local home industries and crafts of the village artisans. Consequently there would be little opening for the displaced labourers in the village industries. The fact has to be faced that the introduction of labour-saving implements and machinery—even putting an efficient steel plough drawn by strong bullocks in place of the present country plough—must tend to reduce the population of the agricultural districts in India as it has done in other countries. Two very difficult questions arise: (1) how a selection is to be made of those cultivators who are to be lucky enough to get the new enlarged holdings; and (2) what is to be done with the surplus able-bodied men who would not be required as labourers, and cannot be allowed to remain destitute in the villages?

The tentative solutions of these problems which I would offer for consideration are as follows: The rentals of the new holdings must necessarily be fixed at a higher rate per acre to cover the cost of reorganization and to cover the interest on capital which, it is hoped, landlords may be induced to spend upon them, or Government to advance; and as most of the holdings would be more than three times the size of the present ones, many of the existing cultivators would be unable to face their high rentals and there would not be excessive competition for the holdings. It might, indeed, in some places be necessary to subdivide some of the larger newly made holdings in order to get tenants who could prove themselves actually able to pay the rent. By such a process of economic selection, *working from a large average size of holding down to such smaller average size as proved itself to be stable,* the best farmers, from

he cultivating and business point of view combined, would be automatically selected. The solution of the second problem of moving the surplus of competent adult labour would, I think, be a double one. Some would be offered the opportunity of taking up waste land in distant parts of India where population is badly needed. Others would be assisted to migrate to the towns where industries are growing; and they would be given every inducement to settle down there so as to form a permanent industrial population.

The enquiries that I have made show that there are waste lands, not only in the Punjab, but also very extensively in the Native States of Rajputana and Central India, such, for example, as Bikanir, Alwar, Patiala, Gwalior, Bhopal, Indore, and Rewa. In many cases irrigation is needed to make these lands available, but if there were prospects of obtaining the population, most of the Native States would be ready enough to carry out the necessary works. I think two million acres could by suitable arrangements be colonized in the Native States. The Punjab will probably fill up its own waste land. The United Provinces with their 47 million inhabitants might well contribute two or three millions for the colonization of the Rajputana and Central India States and for emigration to the Central Provinces where, I am informed, there are still many tracts of waste land on which the Central Provinces Government would be only too glad to locate settlers.* The main difficulty is the difference in type of country, the soil, rainfall and crops being different. It is for this reason that such migrations of cultivators need to be carefully organized. I may suggest that they might be managed and assisted by the Agricultural Departments of the different provinces and States working in co-operation, particular care being taken to see that newly settled colonists are located in villages (ryotwari or zemindari), at the head of which is placed a man of good character, knowing thoroughly from many years' experience the local conditions of agriculture and capable of giving instruction

* Such districts are Chanda, Balaghat, Chhattisgarh, Raipur, and Drug, and to a smaller extent Saugor. For this information I am indebted to the Hon'ble Mr. J. T. Marten, M.A., I.C.S.

therein, which should be made as much one of his official duties as the collection of revenue.

In a similar manner the emigration to growing industrial cities ought to be managed by Government in such a manner as to secure that the newcomer at least begins his industrial career under the most propitious circumstances. It is not too early even now to establish in Cawnpore and all the larger towns Government Labour Bureaus similar to those which have proved so successful in recent years in England. In regard to the immigrants from rural districts the labour bureaus should have a more comprehensive duty than merely finding employment, and should be responsible for securing decent and proper conditions of work, a fair remuneration, and sanitary and comfortable housing accommodation. It is greatly in the public interest for the promotion both of industries and agriculture that these matters pertaining to the welfare of labour in great cities should from the first be controlled in an enlightened manner. There could be no excuse for allowing the repetition in India of the scandalous social conditions which arose in the rapidly growing towns of Great Britain at the time when the agricultural revolution was squeezing the labour into the cities to be rapidly absorbed by the industrial revolution.

Replanning of roads.

A very important part of the reorganization of villages must be the complete replanning of all roads in the village and its neighbourhood. Only those roads which are already drained and metalled as first class roads would be retained in their present alignment. All other roads would be abolished and turned into ploughed fields so that the replanning of rural roads might commence with a clean sheet. The justification for this drastic measure lies in the fact that 95 per cent. of the existing roads were in existence before the railways were constructed, so that the great majority of them have no advantageous relation to the location of the railway stations. It is true that the engineers who planned the railways have often placed stations at points where important main roads, metalled or unmetalled, cross the railway; but the majority of country stations

ave no main roads approaching them, and none near them, except he trunk road which usually runs parallel with the railway.

The ideal arrangement of roads would be a net-work of minor oads converging into more important roads which would themselves converge directly upon the nearest railway stations. In order o get a clear idea of the road system, we must recognize the classes f roads required, which I shall take from the smallest upwards. 'e have first those giving access from the village site to the various rms. These I shall term the "field" roads. As in the Punjab olonies, they would usually run along the edges of the squares and ould be made from 10 to 15 feet wide, according to the number of quares to which they would give access. The metalling of these oads, if any, would be carried out mainly at the expense of the wners of the holdings served. The next class may be called "inter-illage" roads. These would form a net-work of roads going from very village direct to every other adjoining village. The third lass of roads we might call "station" roads, for they would run irect from the villages lying at any distance up to six miles from he railway station by the shortest route to the station, there eing, however, no two roads made at an angle of less than 30° ith one another. The fourth class of roads would be "trunk" oads, provided for fast motor traffic, and in order to give lternative routes for produce to reach the market towns in case of reak-downs on the railway, or of freight rates proving exorbitant or short journeys.

Procedure for consolidation of holdings.

The principles which should guide the choice of a method of arrying out the reorganization of villages on the lines above described are the following. In the first place, compulsion should be voided as far as possible, and the principle adopted that no change hould be imposed upon any area unless the owners of more than ne-half of that area desire the change. Should this condition be atisfied for an area which might be one village, or might embrace or special reasons two or more contiguous villages, it would seem xpedient that legal power should be taken to compel the minority

to accept the redistribution of holdings under the supervision of Government. In the second place, whatever machinery might be established to carry out the redistribution, it must work in such a manner that the expense of the whole operation should be kept as low as possible, and should not in most cases exceed Rs. 15 per acre, excluding the cost of fencing the roads. In the third place, considerable elasticity should be permitted in the methods of carrying through the reorganization in different places during the first few years, as the whole undertaking would be in an experimental stage, so that different methods might be tried, and the best be ultimately selected for a permanent set of regulations. Fourthly, the possible necessity for a considerable change of the existing tenancy law in the reorganized villages must be faced. The present system actually discourages any improvements being made by landlords; and much of the benefit of the change would be lost if some alteration of the tenancy laws were not made concurrently with the reorganization of holdings. I see no difficulty in making a special tenancy law different from the general tenancy law applicable to reorganized villages in which the reorganization has been controlled or approved by Government. For the sake of completeness, I may add as a fifth principle the obvious condition that the redistribution of land must be made upon the most equitable basis possible, and that liberal compensation should be given to those, if any, who may be excluded from a former cultivating ownership.

The first step to be taken by Government would obviously be an Act enabling it to appoint certain officers with powers of receiving, taking into consideration and acting upon applications for the consolidation of holdings in any village or villages. Such a law would appoint a body of commissioners, perhaps five in number, whose duty it would be to receive petitions for consolidation. These commissioners would be jointly responsible for the carrying out of every reorganization, but they would be given the power of appointing one commissioner from among themselves to have special charge of each particular reorganization. Such commissioner would always be an experienced settlement or revenue officer. In carrying out his duties he would be assisted by two assessors who should be

persons of standing with local knowledge of the district, and who should be appointed by the commissioners from a number of suitable persons nominated by the owners and other persons interested in the proposed reorganization.

Prominent public notice having been given in the locality affected, and generally elsewhere by advertisement in the newspapers, that the proposed redistribution of holdings would be taken into consideration, the commissioner would hold a public meeting in the locality and explain, with the help of his assessors, the precise objects of the consolidation, the benefit to be expected, the classes of persons whose interests would be affected and what steps they should take to secure the benefits of the scheme and to protect themselves so far as might be necessary. Notice would then be given to all persons interested to state their claims and objections in writing, for which purpose a legal adviser might perhaps be placed at their disposal at a nominal charge.

As soon as it was made clear that a majority of the ownership of the area, whether reckoned by shares or by area of holdings, was in favour of a redistribution, the commissioners would apply to Government for sanction to proceed. For this purpose they would prepare a report which would be published in the Gazette, and Government would appoint a period of three months to hear objections. If these objections did not appear to warrant the suspension of the application, or abrogation of the proposed proceedings, Government would order the commissioners to proceed after a further period of two months. At this stage it would be open for any objector to appeal to the High Court to stay the proceedings; but this would probably involve considerable expense, and the money would be lost unless the objector could make out a very good case. The necessary period having elapsed and the High Court having issued no order to stay the proceedings, the commissioners would once more hold a public meeting in the locality and explain fully the steps by which they would proceed to effect the redistribution of holdings. They would next appoint competent surveyors and a trained valuer. They would enter into communication with the Public Works Department or the District Board as to the

replanning and the estimating for the roads. With the complete survey before them such questions as joint irrigation and drainage would be investigated; and the question of any demand existing for a new dwelling site could be raised. With all this information in their possession, the commissioners would then proceed to decide what areas should be reserved for grazing and for general purposes; and the remaining area suitable for cultivation would then be divided up for a trial allotment, and a valuation of it on this basis made. At this stage objections might be heard; but they would be largely disregarded if they conflicted with the larger interests and general purpose of the proceedings. Finally, a revised allotment might be made and a final valuation, on the basis of which the various owners would be assessed with the cost of the consolidation. The value of land required for roads other than field roads would be pooled, and deducted *pro rata* from the value of all the new allotments; but the land required to be given up for field roads to other peoples' holdings would be taken into account in deciding the individual allotments.

Methods of enlarging units of cultivation.

The importance of the consolidation of holdings being accompanied by an enlargement of the average size of the unit of cultivation has already been emphasized; and it remains to consider what action the commissioners should be required to take to secure this result. It is obvious that it would not be possible to do very much to compel owners to let their land in large rather than small holdings and the control of sub-lettings would be difficult. The methods likely to be successful would be, on the one hand, to attract likely tenants away from the village and the surrounding neighbourhood, and, on the other hand, to place obstacles in the way of letting small areas.

The first would be accomplished by advertising as thoroughly as possible facilities for emigration to the towns and to districts under colonization in the manner above suggested (*see* p. 339), and by establishing agencies in the locality and for such distance around as seemed necessary in order to lessen the supply of would-be tenants

m the surrounding country. To place obstacles in the way of ting small areas, the commissioner might be required, after allot- g new holdings to the owners, to proceed to define accurately the nvenient farms or letting areas, having powers to insist that all first lettings after the redistribution should be made only in cordance with these areas and without subdivision. If difficulty re experienced in letting, variation should be allowed only with e consent of the commissioner. The commissioners would fix a mber of areas of from 2 to 6 acres each for letting as small holdings, d areas from 16 acres upwards for letting as farms. Power of mpulsory sale of land belonging to any obstructive owner, at the w valuation rate less 10 per cent., must be given to the commis- ners in case the owner were to refuse to allow his holding of, say, or 12 acres to be grouped with another owner's land for letting rposes. A sufficient degree of permanence could be given to the rm areas defined by the commissioners by making it impossible r owners to recover rent by process of law for fractional parts of e officially sanctioned letting areas, unless such fractional parts ere added to an adjoining whole farm and held by the same tenant. hus farms could be amalgamated, or one be divided and its parts dded to adjoining farms, but letting subdivisions of single farms ould be very risky.

The adjustment of occupancy rights might prove troublesome hen the new area to be let to the occupancy tenant exceeded the ld area which he held with occupancy right. The commissioner ight be empowered in such cases to decree a compromise whereby he area covered by occupancy right would be extended n consideration of the rent over the whole being raised to an quitable extent.

Cost of the reorganization.

It is difficult to form any estimate, but it seems probable that the cost of reorganization of areas of not less than 1,000 acres at a time would work out at between Rs. 10 and Rs. 20 per acre, excluding fencing and other physical improvements. The larger the area done in one place, the lower would be the average cost, because the

commissioner and other officers instead of paying occasional visits would reside for months together on the spot. For this reason I would advocate a procedure of placing a whole district at a time under reorganization when a sufficient number of applications had been received from it. In any district thus declared to be under reorganization, the first step would be the preparation of a general plan of trunk, station, and inter-village roads for the whole district. A reorganization commissioner would be assigned to the district for his whole time, just as a settlement officer is, and he would be assisted by different assessors in each pargana or tahsil. In any district declared to be under reorganization Government might agree to do the whole business at a flat rate of Rs. 10 per acre, whilst in isolated areas reorganized elsewhere the charge would be from Rs. 12 to Rs. 20 per acre.

In my opinion there can hardly be any question but that the consolidation of holdings would prove a very profitable operation for landowners. The market value of their lands would probably be increased by about 50 per cent. within the first five years, and still more after another five years, when skill and capital for cultivating the larger holdings would have developed and rents could be substantially raised. It would be wise for Government to undertake not to raise the land revenue *on account of the profits of the consolidation* until the period of one settlement should have elapsed; that is to say, assuming the cost to be borne by the owners. It would probably be a more popular policy, and incidentally profitable to Government, if the latter undertook to bear the whole cost of the reorganization and recouped itself by a special cess or addition to the land revenue calculated at, say, 7 or 8 per cent. per annum on the capital cost of the reorganization.

The necessity for experiment.

In conclusion, I wish again to emphasize the necessity for undertaking experiments in the consolidation of holdings under favourable circumstances in all the different tracts of the country. In the United Provinces, for example, ten different areas, each consisting of one, two or three villages, might be selected, preferably

easily accessible localities. If Government were to offer to bear entire cost of the consolidation of the first 20,000 acres to be dertaken, without enhancement of land revenue, I am sure that re would be no lack of offers of their estates by owners. It would necessary to make it clear that all tenancy difficulties would be nothed over by giving the commissioners special and final powers the purpose in these selected areas. In discussing the matter h enlightened zemindars whom I have happened to meet, the gestion has been received with more favour than I expected, and only serious objection raised has been the expected opposition enants, and the impossibility of forcibly removing the occupancy ant from his fields even by buying him out.

In my opinion there is no reason whatever to wait and study question further before commencing experiments. Study can t be carried on whilst actual operations are proceeding in the cted areas. The nature and extent of the difficulties cannot be overed by any amount of arm-chair thinking beforehand. They st be discovered by experience; and similarly it is the men ually engaged in effecting the reorganization who are the most ly to be able to find solutions for the difficulties they encounter. ourceful and trustworthy men must be selected, and they must necessity be given very wide powers and discretion. Handled s in a spirit of wise liberality, it is difficult to conceive that the at economic change to be thus inaugurated can be anything but neficial in the highest degree to India and the masses of her people.

APPENDIX.

Since the foregoing paper was put into print, I have had the vantage of discussing it with Professor Patrick Geddes, and in light of his friendly criticisms and of the discussion at Poona[1] re are a few words which it seems to me desirable to add. ofessor Geddes observes, with reference to the standard of living ol. XIII, Pt. II, p. 223), that it is raised by three, not two, encies: that is (1) by example, that is desire to imitate or emulate

[1] *Proceedings of the Board of Agriculture in India, Poona*, 1917, p. 26.

persons who possess the means and do actually live at a high standard. Such example is stimulated (2) by travel and its educati effect. The remaining agency is (3) by relevant selection from t resources offered by the present educational system (though this, a whole is too urban in character and thus *townward* in its attracti and suggestive influences). It is probable also, he suggests, th the prevailing low standard of living in India was largely brough about by the necessity for concealment of property and the gener depressive effect of the eighteenth century wars, a result whi has been to a great extent standardized by the nineteenth centur land tenancy legislation.

Another note by Professor Geddes refers to page 332, where advocated that no account should be taken of existing field bou daries. He would have it that some account of them should b taken, not only when field boundaries follow the natural contour of the ground (which, of course, I intended should be followed), bu also so as to avoid breaking home attachments by centring the new holding as far as possible on the family fields and trees, etc., which are most esteemed. If kept in view purely as a subsidiary aim I agree with this also.

Another point is the shape of fields which, as Professor Geddes points out, should be long rectangles for efficiency of ploughing and not closely approximating to squares. The holdings also, he says, should be long rectangles, as nearly as possible radiating from the village site. Again, as occupation for the surplus population Professor Geddes would advocate the further development of forestry, fruit growing and silk culture; whilst a very considerable number of persons would be employed in the ever growing programs of public works.

One of the speakers at the Conference[1] thought that a weak point in my scheme was that the reorganization would produce a complete break with the past traditions of the village. This, however, would not be the case, as I do not propose to break up the village itself, that is the *abadi*, nor its immediate surroundings of

[1] *Ibid.*, p. 34.

ls, tanks, temple and sacred trees. The social centre of village would remain unaffected by the redistribution of fields, and nges in the village buildings would only come about later by a dual process of growth and reconstruction.

I may add that in the section on the enclosure movement in gland reference should have been made to the work of Dr. Gilbert ter, University Professor of Economics at Madras, on *The English untry and the Enclosure of Common Fields*, which gives a clear tement of the methods and results of the enclosures. This book s not available to me when writing, or it would have been men- ned in the paper itself.

EXPLANATION OF VILLAGE MAP.

The lines across the bottom of the map represent the main line the East Indian Railway; and a road crosses near the centre. ere is one principal *abadi*, and there are three subordinate elling sites. These are shown by very heavy black lines forming kind of cellular structure; and streets are shown in two of m. The irregular ovals represent water-tanks, *jhils*, or ponds. r the sake of illustrating the scattered nature of the holdings, the ds actually cultivated by five individual cultivators during the p year 1913-14 have been hatched or stippled with a distinguishing ign as shown in the left-hand lower corner. These five cultivators re chosen at random. It will be seen that, whilst one cultivator ld fields scattered in twelve different places, another (the one th the top design in the key) had only two contiguous fields uated in the extreme north of the village. It is possible this last ntioned cultivator owns or rents lands in a neighbouring village.

Notes.

THE PLANET JUNIOR HAND-HOE: A COMPETITION.

THE makers would surely have been satisfied with the manner of using these handy little tools if they had seen some North-West Frontier Province workmen striving in competition the other day at Tarnab. The hoes were mostly Single-Wheel No. 17 type, and each competitor ran the hoe he customarily used in his daily labour. The tools were dismantled, their parts being placed beside the competitors ready to be adjusted when the word "go" was given. Each man was required to hoe, to cultivate, and to earth up 440 yards of drill. From start to finish the work performed was clean and determined, without undue flurry. The onlookers showed more excitement than the competitors. In altering their tools to suit the work on hand the smaller nimbler men usually gained on their more burly rivals. The cultvation was so uniformly good that the prizes were awarded chiefly for speed. It must not be thought that the competitors sped down their lines in the flowing garments that go to make the picture. (Plate VI.) The men dressed and lined up after the event, for no true Pathan will consent to be photographed if he is not worthily arrayed. They are a fine lot of men, of some character. Ten of the seventeen competitors have been employed at the Agricultural Station almost since operations began there eight years ago.

The writer hopes to contribute in a subsequent issue of this *Journal* a note regarding the employment of the Planet Junior hoes in the North-West Frontier Province.—[W. R. B.]

PLATE

Planet Junior Hand-hoe competition at Tarnab

THE following further communication from Dr. C. A. Barber, .E., on the **origin of the Uba cane,** has appeared in the *Interna-nal Sugar Journal* (September, 1918):—

I am much obliged to you for forwarding an advance copy of . Noel Deerr's interesting statement on the origin of the Uba ne in Natal.[1] One of our greatest difficulties in India is the sence of scientific libraries dating beyond the last few years, and, th regard to sugarcane, the available literature is very limited leed. It is gratifying that my recent letter,[2] suggesting a ssible if somewhat fantastic origin for the word "Uba," has cited a reply from one who has at command an adequate rary.

There are now two theories in the field as to the origin of the tal cane. Both of these must, I think, be examined on the sis that the Uba cane came originally from India, as it is obviously member of the widely spread Pansahi group of indigenous canes. ne first of these is that the Uba cane came direct from India to atal. The distance is small, and Natal formerly lay upon the rect route from India to England, as it does, curiously enough, the present moment! Two obstacles have to be overcome r those in favour of this theory. The first is the *name*, which is ot given in India to any of the Pansahi group, nor indeed to any ther cane that I have met. I do not of course lay any stress on the ggested connexion with the two Burmese words "U-ba," referred o in my letter. The second is that there is no direct evidence of he Uba cane having been brought from India. Unless the cane ame from Burma, where I regard it as an introduction from Bihar, nd where much better canes abound, it is difficult to understand ow else it could have reached Natal. The Pansahi class is not haracteristic of Bengal, which has, and has had for several centuries, number of thicker and better canes. I regard it as unlikely that uch a cane as Uba would have been obtainable, or that, if obtainable, it would have been considered at all a desirable one, to introduce into a foreign country. With the exception of Lower Burma, there

[1] Reprinted in the *Agric. Journ. of India*, vol. XIII, pt. IV.
[2] Reprinted in the *Agric. Journ. of India*, vol. XIII, pt. III.

is a lack of connexion between India and Natal as regards the cane.

The second theory is that the Uba cane came from Brazil and Mr. Noel Deerr gives chapter and verse for this introduction to Mauritius in 1869. But as Mr. Deerr points out, this opens up an interesting speculation. In studying the characters of the indigenous Indian canes and those of the tropics, I have all along been trying to find the line along which the latter might have been evolved from the former. It has always been somewhat loosely considered possible that, during the many hundreds of years of tropical cultivation, the Indian canes may have been so altered in their growth that they assumed the present form of the thicker canes. But if the cane which Alexander took from India over 2,000 years ago has so little changed in its character that it can unhesitatingly be placed in its own class of Indian canes, this idea receives a severe check. What chance was there that Alexander came into closer contact with the Pansahi group than the Natal planters?

The canes of the Punjab are of two classes. Near big towns we have thick tropical canes which are used for chewing and are heavily manured and cut before they are ripe. These grow well at Amritsar, where I have met with and studied two kinds. Thick canes are again found in the neighbourhood of Peshawar, where frost is absent and some 30,000 acres are grown on a crop scale for making *gur*. But all the evidence is that these canes have been introduced comparatively recently into this part of India, and I do not think it at all likely that, when Alexander came to India, there were any but the thin frost-resistant forms which are still growing in the fields. These are described by me in a Memoir of the Indian Agricultural Department, and it will be readily conceded that they are among the thinnest and most primitive canes in the world. But among them is one of the Pansahi class, described as non-resistant to frost, occasionally being totally wiped out, and then, for several years, being gradually re-introduced, from the East where the true zone of the Pansahi group lies, along the foot of the Himalayas as far as Bihar. This cane is called *Kahu*. It is

own in the neighbourhood of the Beas river and is valued in that s less fibrous and more juicy than the other more grass-like canes the province. Now, Alexander in his Indian irruption came as as the Hyphasis river, the ancient name for the Beas. Naturally would take the best cane he could meet with, and the point of ntact is perfect, if the local canes growing then were the same as se now found in the province.

Can other links in the chain of evidence be found? Is it ssible that in corners of Spain there may still be remnants of the ne that Alexander took? Can the local reed-like cane of Brazil be ll found in the primitive Indian settlements of the country? d if so, is it of the Pansahi class? Is there any other source of e Brazil canes, in Japan for instance?

The importance of these questions on the origin of the cultivated garcane cannot be exaggerated. There are, I believe, many erences to the introduction to the West of canes "from Malabar," d these were thick tropical canes. This has led to an idea that dia itself might contain the links of the chain of development tween the indigenous canes of the country and the thick canes the tropics. But, if this is so, how can we explain the fact that South India there are at least four indigenous varieties, *Naanal* the south of Madras, *Hotte Cheni* and *Ganda Cheni* in Mysore, d *Hullu* in Canara? These are easily distinguishable from the ick, introduced canes, and there is no suggestion of their not having en in the country for many generations. They are thicker than e Punjab canes, although belonging to the same class, as has been early shown in a recent Memoir prepared by me and about to ue from the press. In fact, to sum up the discussion, it seems me that Mr. Noel Deerr's letter suggests much more strongly an has ever been done before, that the thick canes and the indiinous Indian canes have had an entirely different origin, the latter aving arisen from one or more wild forms similar to those now owing in India, and the former from another species of Saccharum, obably now extinct in its wild form, and native to the islands f the Malay Archipelago, or possibly Cochin China, as suggested de Candolle's "Origin of Cultivated Plants."

SUGAR FACTORIES IN INDIA.

A PRESS COMMUNIQUE, dated 3rd December, 1918, issued the Department of Statistics, India, says:—

Enquiries were recently undertaken by the Department Statistics, India, regarding the sugar producing capacity of t sugar factories in India. Of the forty-six factories to whi enquiries were addressed, returns from thirty were received. Of th remaining sixteen, six did not give any reply, six others were eith closed or were not in working order, business was not started b two, one was opened only in August, and one was omitted as produced only molasses.

The results of the census show that the thirty factories tur out per day of twenty-two hours 4,900 maunds (of 82·3 lb. eac of sugar from cane (first sugars), 2,100 maunds from cane (secon sugars), 7,200 maunds from raw sugar, 3,600 maunds of molasse from cane, and 3,700 maunds from raw sugar, employing on a average 8,600 persons daily. The maximum amount of sugar that can be produced by these factories is, according to the return furnished, 14,500 maunds (or 533 tons) per day. The details fo the provinces are given in the statement below:—

Province	Number of factories	SUGAR PRODUCED FROM			MOLASSES PRODUCED FROM		MAXIMUM PRODUCTION		Average number of persons employed daily
		Cane—first sugars	Cane—second sugars	Raw sugar	Cane	Raw sugar	Sugar	Molasses	
		Mds.	Mds.	Mds.	Mds.	Mds.	Mds.	Mds.	
Bihar and Orissa ..	13	2,853	758	1,262	1,654	1,156	4,829	2,606	5,00
United Provinces ...	9	1,015*	802	1,737	1,142†	1,592†	3,831	2,936†	2,65
Madras	5	975	507	1,411	861	828	2,246	1,233	2,05
Bengal and Punjab ...	3	32	17	2,823	22	139	3,550	324	85
Total	30	4,875	2,084	7,233	3,579	3,715	14,456	7,099	8,60

* Includes production of second sugars in one factory, separate figures not being avail able. The high proportion of second sugars in the United Provinces is due to the fact that ration sugar of about 98 degrees polarization, manufactured for the Army Department, has been classed under "second sugars."

† Excluding production of molasses in one factory, information not being available.

The department is greatly obliged to manufacturers throughout ia for their invaluable assistance throughout this enquiry. The gestion which has been made to hold the enquiry periodically guide to the progress of the industry is under consideration.

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IE INHERITANCE OF MILK AND FAT PRODUCTION IN CATTLE.

At the Maine Agricultural Experiment Station Mr. John Gowen has made a genetic study of the first-generation crosses prominent dairy breeds of cattle and beef-bred Aberdeen-Angus. s work, the results of which are published in the *Journal of icultural Research* (Vol. XV, October 1918, pp. 1-57, 6 plates), undertaken as a link in the chain of evidence necessary to the l solution of the problems which are connected with the inheri- ce of milk production and butter-fat production. A cross-bred d is being formed at the experiment station so as to provide as ch material as possible for the analysis of the laws of heredity ncerned with the productivity referred to, and this herd has now e into its second generation.

An indication may be given of some of the important results eady reached by Mr. Gowen :—

(1) Black body colour is dominant to the other colour in the t generation. In the second generation an orange-coated bull d a dark Jersey dun-coated heifer were segregated out.

(2) White marking of the body, taken as a whole, appears a dominant. Study of individual white areas, however, indicates at this is due to white in the inguinal region only, for this alone pears as such a dominant. White spots on the face, neck, shoul- rs, rump, flanks, and legs are generally suppressed in the offspring nen the white-spotted individuals are mated to solid colour.

(3) Pigmented muzzle is dominant to one not so pigmented.

(4) A pigmented tongue is dominant to a non-pigmented ne—a confirmation of a previous result.

(5) A black switch appears to cause the suppression of the her switch colours in the offspring.

(6) Some exceptions were found to the previously accepted hypothesis of simple dominance of polledness over the horned condition, and it is suggested that a hormone secreted by the testes may have some influence on the presence or absence of horns. Should this prove true, it would establish an interesting parallel between cattle and sheep, for in the latter a sex hormone is known to affect the development of the horns.

(7) The qualities of beef production are shown to be divisible into four general regions of the body: head, forequarters, barrel, and hindquarters. When either parent is of Aberdeen-Angus breed the offspring show the characteristic type of head and heavy, deep-fleshed forequarters. The body and hindquarters appear intermediate, but resemble most the dairy parents. From his results so far the author concludes that for the improvement of the beef qualities of dairy breeds the first generation crosses show an increased value of the beef qualities in the forequarters without materially influencing the hindquarters.

(8) A few data are supplied as to the production of milk and butter-fat by some of the cross-breds. The results indicate that milk and fat production behave separately in inheritance. High milk production is dominant to low, but, unfortunately, a high fat percentage in the milk is recessive to a low fat percentage. The author supplies a useful bibliography and numerous illustrations. [*Nature*, dated January 30th, 1919.]

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NATIONAL INSTITUTE OF AGRICULTURAL BOTANY.

At a meeting at the Cannon Street Hotel, on 15th July, 1918, under the auspices of the Agricultural Seed Trades Association of the United Kingdom, Mr. Lawrence Weaver, C.B.E., Controller of Supplies, Food Production Department, announced that Sir Robert McAlpine and Sons had contributed to the endowment of the National Institute of Agricultural Botany a sum of £10,000 in addition to £1,000 a year for five years, and five other gentlemen had given £1,000 each, while the Association of Corn and Agricultural Merchants and the Millers Association had also opened subscription

s for their members. At the close of the meeting it was nounced that the Seed Trade had contributed over £10,500 which since increased to £13,000. Mr. Weaver explained that none of money subscribed would be used for building the Official Seed sting Station. This would form part of the Institute, but its t would be provided by the Board of Agriculture. The Trust nd, so far, amounts to about £36,000, and it is hoped will reach 0,000.—[*Journal of the Board of Agriculture*, August 1918, p. 518.]

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THE BRITISH DYE INDUSTRY.

* * * * * *

It is satisfactory to find that the Port Ellesmere Indigo Factory s been in full work for some time, and that land has been secured considerable extensions of the works in the near future.—[*Nature*, ted January 16th, 1919, p. 388.]

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

WOODHOUSE-SOUTHERN MEMORIAL FUND.

THE following donations have been received in answer to the appeal in the January Number, for funds to establish Memorial Prizes to perpetuate the memory of these officers.

As I may be going on leave shortly, will future subscribers kindly send their donations direct to the National Bank of India, Limited, Calcutta? Cheques should be crossed "Woodhouse-Southern Memorial Account."

J. MACKENNA.

1*st March*. 1919.

Donations received up to 28th February. 1919.

	Rs.
The Hon'ble Sir Claude Hill, I.C.S.	50
The Hon'ble Mr. R. A. Mant, I.C.S.	30
J. Mackenna, Esq., I.C.S.	100
Dr. C. A. Barber	100
G. A. D. Stuart, Esq., I.C.S.	75
F. R. Parnell, Esq.	10
The Hon'ble Mr. H. R. C. Hailey, I.C.S.	15
Botanists, C. P.	30
W. Robertson Brown, Esq.	15
G. S. Henderson, Esq.	50
C. P. Mayadas, Esq.	50
Anonymous (S)	50
Carried forward Rs. ..	535

	Brought forward	Rs. 535
H. D. Watson, Esq., I.C.S. (S)	.. .. ..	25
Dr. E. J. Butler	.. .. ..	50
A. Howard, Esq.	.. .. ..	25
Mrs. Gabrielle L. C. Howard	.. .. ..	25
Dr. W. H. Harrison ..	.. .. ..	30
C. M. Hutchinson, Esq. ..	.. .. ..	30
T. Bainbrigge Fletcher, Esq. ..	.. .. ..	25
Dr. F. J. F. Shaw ..	.. .. ..	25
Wynne Sayer, Esq. ..	.. .. ..	50
M. Afzal Hussain, Esq. ..	.. .. ..	25
W. A. Davis, Esq. ..	.. .. ..	20
H. E. Annett, Esq. ..	.. .. ..	15
C. Somers Taylor, Esq. ..	.. .. ..	50
A. Carruth, Esq.	.. .. ..	100
	TOTAL RS. ..	1,030

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HIS EXCELLENCY THE VICEROY, accompanied by the Hon. Sir ude Hill, paid a visit to Pusa from the 4th to 6th January, 1919. s Excellency was shown over the various sections of the Institute d evinced much interest in all that he saw.

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THE New Year Honours' List contains the following names ich will be of interest to the Agricultural Department :—

K.C.I.E. THE HON'BLE MR. N. D. BEATSON-BELL, C.S.I., C.I.E., I.C.S., Chief Commissioner, Assam (sometime Director of Land Records and Agriculture, Eastern Bengal and Assam).

C.B.E. MR. E. A. MOLONY, I.C.S., Commissioner, Agra Division, United Provinces (sometime Offg. Director of Land Records and Agriculture, United Provinces).

M.B.E. MR. B. C. BURT, B.Sc., Deputy Director of Agriculture, United Provinces.

Khan Bahadur. MR. JUDAH HYAM, F.Z.S., Veterinary Overseer, Agricultural Research Institute, Pusa.

Rao Saheb. M. R. RY. M. R. RAMASWAMI SIVAN, Avargal, B.A., Senior Assistant to the Government Agricultural Chemist, Coimbatore, in the Madras Presidency.

Rao Saheb. Mr. Kasanji D. Naik, M.A., Assistant Superintendent, Office of the Agricultural Adviser to the Government of India, Pusa.

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Lieutenant-Colonel G. K. Walker, C.I.E., F.R.C.V.S. Indian Defence Force, has been appointed to be an Officer of the Most Exalted Order of the British Empire for services brought to notice in His Excellency the Commander-in-Chief's Despatch dated the 20th August, 1918.

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Dr. E. J. Butler, M.B., F.L.S., Imperial Mycologist, has been appointed Joint Director of the Agricultural Research Institute, Pusa, in addition to his present duties, with effect from the 20th January, 1919, and until further orders. The post of Assistant to the Agricultural Adviser is placed in abeyance.

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Mr. G. S. Henderson, N.D.A., N.D.D., has been confirmed in the appointment of Imperial Agriculturist with effect from the 1st March, 1918.

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Mr. Wynne Sayer, B.A., whose appointment as Assistant to the Agricultural Adviser to the Government of India has been temporarily placed in abeyance, is, with effect from the 20th January, 1919, appointed to officiate as Imperial Agriculturist, during the absence, on deputation under the Munitions Board, of Mr. G. S. Henderson, or until further orders.

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Mr. M. Afzal Hussain, M.Sc., has been appointed Supernumerary Entomologist, Pusa.

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Dr. W. Burns, Economic Botanist to Government, Bombay, has been allowed, with effect from the 15th January, 1919, combined leave for six months.

Mr. S. L. Ajrekar, B.A., Assistant Professor of Mycology the Agricultural College, Poona, has been appointed to act Economic Botanist to the Government of Bombay, *vice* Dr. Burns, granted leave.

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Mr. M. H. Sowerby, M.R.C.V.S., Assistant Principal, Bombay terinary College, is granted furlough for three months with ect from 1st August, 1919.

Mr. N. D. Dhaknarvala, First Professor, will officiate in place Mr. Sowerby, pending further orders.

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His Majesty's Secretary of State for India has appointed P. H. Rama Reddi as Deputy Director of Agriculture, Madras, probation for three years. He has been posted to the Agricul- ral College and Research Institute, Coimbatore, for training.

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M. R. Ry. J. Chelvaranga Raju Garu, Deputy Director of griculture, IV Circle, Madras Presidency, is granted privilege ave for one month.

M. R. Ry. C. Narayana Ayyar, Avargal, Assistant Director Agriculture, on relief from the VI Circle, will be in charge of the V Circle.

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Mr. F. Smith, B.Sc., F.H.A.S., M.R.A.S.E., Deputy Director Agriculture, Western Circle, Bengal, has been allowed combined ave for 14 months with effect from the 15th January, 1919.

Babu Rajeswar Das Gupta, Superintendent of Agriculture, is ppointed to act as Deputy Director of Agriculture, Western Circle, ice Mr. F. Smith.

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Mr. A. C. Dobbs, B.A., Deputy Director of Agriculture, Chota gpur Circle, has been appointed to act, in addition to his own

duties, as Director of Agriculture, Bihar and Orissa, during absence, on deputation, of Mr. G. Milne, I.C.S., or until furt orders.

***

Mr. J. Robinson, N.D.D., Offg. Deputy Director of Agricultu Patna Circle, Bihar and Orissa, was granted privilege leave f one month and fifteen days with effect from the 2nd January, 191

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Mr. H. L. Datta, B.A., M.Sc.A., Assistant Professor of Ento mology, Sabour Agricultural College, has been appointed to act a Economic Botanist, Bihar and Orissa, *vice* Mr. E. J. Woodhous deceased, during the absence, on deputation, of Mr. S. K. Basu, M.A appointed to act as Deputy Director of Agriculture, Orissa Circle, a until further orders.

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Mr. H. M. Leake, M.A., F.L.S., Offg. Principal, Agricultura College, Cawnpore, has been confirmed in that appointment, *vic* Mr. A. W. Fremantle, retired.

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Mr. W. Roberts, B.Sc., Principal and Professor of Agriculture Punjab Agricultural College, Lyallpur, has been granted combine leave for three months with effect from the 8th January, 1919.

Mr. B. H. Wilsdon, B.A., Agricultural Chemist, Punjab, officiates as Principal.

Mr. O. T. Faulkner, B.A., Deputy Director of Agriculture Punjab, has been appointed to officiate as Professor of Agriculture.

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Malik Sultan Ali, who has been appointed by His Majesty's Secretary of State for India to the Indian Agricultural Service in the Punjab, has assumed charge as a Supernumerary Deputy Director of Agriculture, and has been posted to Lyallpur for training.

Mr. G. Taylor, M.R.C.V.S., on reversion from Bombay to the il Veterinary Department, Punjab, resumed charge of his duties Superintendent, South Punjab, with effect from the 8th January, 19.

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Maung Ba Kyaw, temporary Engineer in the P. W. D., Burma, ose services have been transferred to the local Agricultural partment, has been appointed as an Agricultural Engineer in the partment with headquarters at Mandalay.

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Mr. F. J. Plymen, A.C.G.I., Indian Agricultural Service, has en nominated a member of the Legislative Council of the Chief mmissioner of the Central Provinces in place of the Hon'ble . Hughes-Hallett, resigned.

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On being released from military duty, Mr. A. G. Birt, B.Sc., appointed Deputy Director of Agriculture, Assam.

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Mr. W. Harris, M.R.C.V.S., Superintendent, Civil Veterinary partment, Assam, has been granted combined leave for six nths from 15th April, 1919.

Reviews.

Plant Products and Chemical Fertilizers.—By S. Hoare Collins M.Sc., F.I.C. (London: Baillière, Tindall & Cox.) Price 7s. 6d

This book forms one of a series of volumes now being issued under the editorship of Dr. S. Rideal, which aims at giving a comprehensive survey of the chemical industries. In the general preface to the series, Dr. Rideal states that in these monographs "an attempt will be made to get away from the orthodox text-book, manner, not only to make the treatment original but also to appeal to the very large class of readers already possessing good text-books of which there are quite sufficient. The books should also be found useful by men of affairs having no special technical knowledge, but who may require from time to time to refer to technical matters in a book of moderate compass, with references to the large standard works for fuller details on special points if required."

Within the limits imposed by this scheme Mr. Collins has performed his task well. To the special student of agriculture it is possible that the treatment of some of the subjects will appear rather sketchy, but to the general reader or graduate of a science course the book will probably appeal as a useful introduction to a large subject.

The first 60 pages (Part I) deal in general terms with the principal classes of fertilizers. In Part II (40 pages), soils, soil improvers and soil reclamation are discussed. In Part III (78 pages), a very general account is given of the principal plant products—carbohydrates produced by crops, oils, nitrogen compounds of plants and

cellaneous plant products, such as tea, coffee, rubber, indigo. Part IV. the author deals with the production of meat, manuring meat, the nature of the cattle foods, their calorific value and ry products.

At the end of each section a list of text-books and recent papers ling with the particular subjects of that section is appended, which uld serve as a useful guide to the reader who requires more detailed rmation.—[W. A. D.]

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Chemistry of Farm Practice.—By T. E. KEITT. (New York: J. Wiley & Sons, Ltd., Inc.; London: Chapman & Hall, Ltd.) Price 6*s. net.*

THIS book is intended by its author to furnish the fundamentals chemistry required for intelligent agriculture, and to apply this wledge to the art of agriculture and its problems. In addition the commoner problems associated with soils and fertilizers and ls, it attempts to include subjects such as sanitary water, boiled er, and insecticides which, in the words of the preface, "are jects in which not only the farmer but the suburban resident is rested." It will be understood by this that the subject matter liffuse in character, and a large number of subjects are touched in the 243 pages which the book contains.

The early chapters are devoted to general chemistry. In these, h terms astatomic weight, valency, compounds and mixtures are ply explained, rules regarding the representation of chemical pounds by formulæ are given, and the processes of oxidation l reduction are outlined in popular fashion. Chapter IV deals h the preparation and properties of the elements necessary for nt growth. Attention is given to the importance of nitrogen l its fixation by bacterial flora in the soil, and by those living symbiosis with legumes, but little emphasis appears to be given the use of nitrogen by plant in combined forms.

In the chapter devoted to water, the requirements of the subur- n reader get more attention and a fair amount of space is taken by the solvent properties of water and its suitability for drinking.

The characteristics which may make it more or less suitable for irrigation have been passed over.

In dealing with air in the soil an attempt has been made to deal with the diffusion of gases in the soil. This appears somewhat too advanced for a book of this type, and is too shortly dealt with to be of much use to the reader.

The same criticism might be made with reference to the section on the leaching of plant food from plants in the next chapter. In both cases the space taken might have been better given to a slightly fuller treatment of the more elementary aspects of the subjects covered.

The chapters on soil formation, fertility, manures and fertilizers and their application give the reader useful information. Though in comparing the use of green crops as direct manure and after feeding in the form of excreta, slightly undue importance is given to the loss of carbon in the latter's formation and on the resulting value. While the relation between the manurial constituents of the food consumed and those of the excreta voided might have been more clearly impressed. Terms like denitrification and fixation of nitrogen have been used in a somewhat loose sense. It is also doubtful as to how far the public for whom the book is intended would be in a position to apply the information detailed in Chapter XV, which deals principally with laboratory methods of estimation. The space devoted to feeding and dairying is not large. The former might have been improved by more emphasis on the importance of digestibility and by some reference to the energy value of the food.

The chapters given to insecticides and fungicides and to paints whitewashes and concrete are instructive. The illustrations are good. It is doubtful whether the book as a whole would prove of much value to a student at an agricultural college in India. In the case of a short course student it might be at times referred to as giving a simple chemical explanation of a portion of an agricultural lecture, or as something to read to emphasize the subject matter taught in a lecture. To a student in the upper classes, who is studying agricultural chemistry, it is of little or no use, as generally the treatment is

superficial in character. On the other hand, it is beyond the ian farmer and high-school boy of the present day.—[R. G. A.]

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We have received from Mr. A. B. Modak, the enterprising d of the Union Agency of Bombay, a firm dealing in seed, concen- ted manures, and other agricultural requisites, an illustrated chure giving an account of the present condition and future spects of potato cultivation in the Bombay Deccan from the pen Dr. Harold H. Mann, Principal of the Poona Agricultural College, l also a description of the **Potato Works** started by the firm. se Works have been **started by the Union Agency** with the p of Government and in co-operation with the Agricultural partment, to put on the market good acclimatized potato seed, and carry on research with a view to introduce improvements in the tivation and manuring of this important crop. In spite of the l-known profitableness of this crop in the Bombay Deccan, it is present restricted to only 8,000 acres. This has been due mainly the difficulty in maintaining the quality of the seed potatoes. is necessary to import annually large quantities of seed from ly, while the prevalence of certain diseases of the growing plant l of the tubers in storage and the smallness of yield owing to the of inferior seed and faulty methods of cultivation have tended restrict the area under this crop. The problems involved there- require to be dealt with from the mycological, entomological, mical, and agricultural sides simultaneously, and though some k had been done departmentally in the past, it was not possible the department with its small staff spread over a large area to centrate on a single problem in a single locality. It is, therefore, tifying that a commercial company has come forward to co- rate with the department, so that by pooling their staff and funds h concentration can be brought about. During the short period its existence the Works have already negotiated over 800 tons of d potatoes, and extracts from letters of those who have tried the d, which are published in the brochure, show very encouraging ults. The agent used for fumigation is petrol vapour, whereby

liability to fungal or insect disease, both in the field and in storage, is eliminated to a great extent. The Works are also designing improvements in the implements used in potato cultivation, and are experimenting with various manure mixtures mainly with the assistance of Dr. Mann who has succeeded in obtaining some very good results. The Works are conducted by a staff of agricultural graduates, and it is encouraging to find that students trained in our Agricultural Colleges do not look merely to service under Government, but have now begun to put to practical use what scientific instruction they have received.—[EDITOR.]

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Household Dairying (in Marathi).—By B. K. Ghare, L.Ag., Lecturer Agricultural College, Cawnpore. Pages 4+48. (Poona: Arya Bhusan Press.)

THIS is the third of the series of books on milk and dairying in its different aspects, so far published by the author. The four chapters into which this little book is divided deal with (1) milk (2) dairying, (3) care of animals, and (4) the feeding of infants, and under each head broad facts of the subject are carefully selected and given the prominence they deserve.

It also summarizes in a very concise manner the crude and objectionable Indian methods of dealing with milk from the time it is drawn to the time it is consumed in an Indian household. The author suggests some adoptable Western methods for the improvement of the existing dairy practices in the country and brings forcibly and clearly to the notice of the reader the importance of thorough cleanliness in the handling of milk and its products, of the milk utensils as well as the milk room, and the preservation of milk in all its purity under varying conditions.

We have, however, found some slight inaccuracies in the book. For example, it is not correct to say that colostrum milk is yielded by the cow after parturition only for a couple of days, and that the buffalo is an aquatic animal from its fondness for water. Such loose expressions should be avoided when bringing out another

ition of the pamphlet. We do not think the advice given about king cattle to the river daily for a wash and swim is sound and ch as can be safely recommended.

Our opinion of this little book is, however, very favourable, and is to be hoped that it will help in dispelling the general ignorance out milk sanitation which seems to prevail. It will be studied th profit by all interested in the sanitary production and handling milk.—[J. H.]

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS.

1. Cotton, by G. Bidgwood. Pp. viii+294. ("Staple Trades and Industries.") (London: Constable & Co., Ltd.) Price 6*s.* 6*d.* net.

2. Tea, by D. Hunter. ("Staple Trades and Industries.") (London: Constable & Co., Ltd.)

3. A System of Physical Chemistry, by Prof. W. C. MacLewis Vols. II & III. (London: Longmans & Co.)

4. Methods of measuring Temperature, by Dr. Eyer Griffiths With an Introduction by Principal E. H. Griffiths. Pp. xi+176. (London: Charles Griffin & Co.) Price 8*s.* 6*d.* net.

5. Winter Botany, by Prof. W. Trelease. Pp. xxxii+384 (Urbana: Prof. W. Trelease.) Price 2.50 dollars.

6. A History of Chemistry, by Prof. F. J. Moore. Pp. xiv+292 (New York: McGraw-Hill Book Co., Ltd.) Price 12*s.* 6*d.* net.

7. The Quantitative Method in Biology, by Prof. J. Macleod (Messrs. Longmans & Co.)

8. School Entomology: An Elementary Text-book of Entomology for Secondary Schools and Agricultural Short Courses, by E. Dwight Sanderson and L. M. Peairs. Pp. vii+356. (New York: J. Wiley & Sons, Inc.; London: Chapman & Hall.) Price 7*s.* net.

Modern Fruit-Growing, by W. P. Seabrook. Pp. xliii+172. (London: The Lockwood Press.) Price 4*s*. 6*d*. net.

Introduction to Inorganic Chemistry, by Prof. A. Smith. Third Edition. Pp. xiv+925. (London G. Bell & Sons, Ltd.) Price 8*s*. 6*d*. net.

Experimental Inorganic Chemistry, by Prof. A. Smith. Sixth Edition. Pp. vii+171. (London: G. Bell & Sons, Ltd.) Price 3*s*. 6*d*. net.

Laboratory Outline of College Chemistry, by Prof. A. Smith. Pp. v+206. (London: G. Bell & Sons, Ltd.) Price 3*s*. net.

All alive O? A Vade Mecum for Breeders and Feeders of Horses, etc., by J. G. Lyall. Pp. 86. (Lincoln: Lyall & Sons.) Price 2*s*. 6d.

A Junior Course of Practical Zoology, by the late Prof. A. Milnes Marshall and Dr. C. H. Hurst. Eighth Edition, Revised by Prof. F. W. Gamble. Pp. xxxvi+515. (London: J. Murray.) Price 12*s*. net.

Plant Physiology, by Prof. V. I. Palladin. Authorised English Edition. Edited by Prof. B. E. Livingston. Pp. xxv+320. (Philadelphia: P. Blakiston's Son & Co.) Price 3 dollars net.

Stoichiometry, by Prof. S. Young. Second Edition. Pp. xiv+363. (London: Longmans, Green & Co.) Price 12*s*. 6*d*. net.

A Manual of Elementary Zoology, by L. A. Borrdaile. Second Edition. Pp. xiv.+616. (London: H. Frowde and Hodder and Stoughton). Price 16*s*. net.

Forced Movements, Tropisms, and Animal Conduct, by Dr. J. Loeb. (Monographs on Experimental Biology.) Pp. 209. (Philadelphia and London: J. B. Lippincott Co.) Price 10*s*. 6*d*. net.

Catalysis in Industrial Chemistry, by Prof. G. G. Henderson. Pp. ix+202. (London, Longmans, green & Co.) Price, 9*s*. net.

The following publications have been issued by the Imper Department of Agriculture in India since our last issue :—

Memoirs.

1. The Rice Worm (*Tylenchus angustus*) and its Control, by E. Butler, M.B., F.L.S. (Botanical Series, Vol. X, No. 1 Price, Rs. 1-4 or 2.
2. Cholam (*A. Sorghum*) as a Substitute for Barley in Malt Operations, by B. Viswanath, T. Lakshmana Row, B.A and P.A. Raghunathaswami Ayyangar, Dip Ag. (Chemic Series, Vol. V, No. 4.) Price, As. 12 or 1*s*.

Bulletins.

1. Are Camels susceptible to Black Quarter, Hæmorrhag Septicæmia, and Rinderpest ? by H.E. Cross, M.R.C.V.S D.V.H., A. Sc. (Bulletin No. 80.) Price, As. 4 or 5*d*.
2. Progress of the Sugarcane Industry in India during the year 1916 and 1917. Being Notes submitted to the Meeting o the Board of Agriculture in India, Poona, 1917. Edite with an Introduction, by C. A., Barber, C.I.E., Sc. D F.L.S. (Bulletin No. 83.) Price, As. 5 or 6*d*.
3. Soil Drainage, by R. G. Allan, M.A. (Bulletin No. 8 Price, As. 4 or 5*d*.

Report.

1. Report on the Progress of Agriculture in India for the yea 1917-18. Price, Rs. 1-8 or 2*s*. 3*d*.

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1ST AUGUST, 1918, TO 31ST JANUARY, 1919.

	Title	Author	Where published
	GENERAL AGRICULTURE.		
1	The *Agricultural Journal of India*, Vol. XIII, Part IV, Vol. XIV, Part I. Price Rs. 2; annual subscription, Rs. 6.	Edited by the Agricultural Adviser to the Government of India, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
2	Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist) for 1917-18. Price R. 1-4 or 2s.	Issued from the Agricultural Research Institute, Pusa.	Government Printing, India, Calcutta.
3	Report on the Progress of Agriculture in India for 1917-18. Price R. 1-8 or 2s. 3d.	Agricultural Adviser to the Government of India, Pusa.	Ditto.
4	Estimates of area and yield of principal crops in India, 1917-18. Price As. 8.	Issued by the Department of Statistics, India.	Ditto.
5	Quinquennial Report on the average yield per acre of principal crops in India for the period ending 1916-17. Price As. 12 or 1s. 2d.	Ditto ..	Ditto.
6	Agricultural Statistics of India, Vol. II, 1915-16.	Ditto ..	Ditto.
7	The best means of rapidly increasing the Outturns of Food Crops by methods within the power of the Agricultural Department. Being Notes submitted to the Meeting of the Board of Agriculture in India, Poona, 1917. Pusa Agricultural Research Institute Bulletin No. 84. Price As. 4 or 5d.	Issued from the Agricultural Research Institute, Pusa.	Ditto.
8	Soil Drainage. Pusa Agricultural Research Institute Bulletin No. 85. Price As. 4 or 5d.	R. C. Allan, M.A., Principal, Agricultural College, Nagpur.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
		General Agriculture—contd.	
9	The Future Prospects of the Natural Indigo Industry. The effect of superphosphate manuring on the yield and quality of the Indigo plant. Pusa Agricultural Research Institute Indigo Publication No. 4. Price As. 4 or 5*d.*	W. A. Davis, B.Sc., A.C.G.I., Indigo Research Chemist to the Government of India.	Government Press, India, Calcutta.
10	*Krishi Samachar.* Price As. 12.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
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LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

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33	Report of the Work of Hagari Agricultural Station for 1917-18. Price A. 1-6 or 2*d*.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
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38	Certificated Drivers for Ryots' Pumping Engines. Madras Department of Agriculture Leaflet No. 3 of 1918.	Ditto ..	Ditto.
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40	Year Book, 1918, of the Madras Agricultural Department. Price R. 1-2 or 1*s*. 9*d*.	Ditto ..	Ditto.
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42	Season and Crop Report of the Central Provinces and Berar, for 1917-18. Price As. 8 or 9*d*.	Ditto ..	Ditto.
43	Report on Agricultural Stations, Northern Circle, for 1917-18. Price As. 8.	Ditto ..	Ditto.
44	Report on Agricultural Stations, Western Circle, for 1917-18. Price As. 8.	Ditto ..	Ditto.
45	Report on the Experimental Farm attached to the Agricultural College, Nagpur, for 1917-18 Price As. 8.	Ditto.	Ditto.
46	Report on the Demonstration Work in the Northern Circle for 1917-18. Price As. 8.	Ditto ..	Ditto.

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Report on the Demonstration Work in the Western Circle for 1917-18. Price As. 8.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
Report on the Agricultural College, Botanical and Chemical Research, and Maharajbagh Menagerie, for 1917-18. Price As. 8.	Ditto ..	Ditto.
The *Agricultural and Co-operative Gazette* (Monthly), from August 1918 to January 1919. Price As. 2 per copy.	Ditto ..	Shalom Press, Nagpur.
Cultivator's Leaflet No. 49. Cold Weather Castor Seed (in English and Burmese.)	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
Annual Report of the Department of Agriculture, Assam, for the year ending 30th June, 1918. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
Annual Report of the Jorhat Agricultural Experiment Station for the year ending 30th June, 1918.	Ditto ..	Ditto.
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59	Report on the Season and Crops of the North-West Frontier Province for 1917-18. Price R. 1 or 1*s.* 4*d.*	Issued by the Department of Agriculture, North-West Frontier Province.	Sham Lall & Sons, Peshawar.
60	Annual Report of the Peshawar Agricultural Station at Tarnab for the year ending 30th June, 1918.	Ditto ..	Ditto.
61	The Silo and Silage or Method of protecting India's cattle from Starvation.	Sam Higginbottom, M.A., Director of Agriculture, Gwalior.	Alijanh Darbar Press, Gwalior.
62	The *Journal of the Madras Agricultural Students' Union* (Monthly). Annual subscription R. 1.	Madras Agricultural Students' Union, Coimbatore.	Literary Sun Press, Coimbatore.
63	*Quarterly Journal of the Indian Tea Association.* Price As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
64	The *Journal of Dairying and Dairy-Farming in India* (Quarterly). Subscription Rs. 5 per annum (including membership).	Published by the Indian Committee of the Dairy Education Association, Quetta.	Messrs. Thacker, Spink & Co., Calcutta.
65	*Poona Agricultural College Magazine* (Quarterly). Annual subscription Rs. 2.	College Magazine Committee, Poona.	Arya Bhusan Press, Poona.
66	*Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual subscription Rs. 3.	Mysore Agricultural Experimental Union.	Bangalore Press, Bangalore.
		AGRICULTURAL CHEMISTRY.	
67	Experiments on the Improvement of the Date Palm Sugar Industry in Bengal. Memoirs of the Department of Agriculture in India. Chemical Series, Vol. V, No. 3. Price R. 1 or 1*s.* 6*d.*	Harold E. Annett, B.Sc., F.I.C., Agricultural Chemist to the Government of Bengal, and Gosto Behari Pal, M.Sc., and Indu Bhushan Chatterji, Assistants to the Agricultural Chemist to the Government of Bengal.	Messrs. Thacker, Spink & Co., Calcutta.
68	Cholam (*A. Sorghum*) as a Substitute for Barley in Malting Operations. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. V, No. 4. Price As. 12 or 1*s.*	B. Viswanath, T. Lakshmana Row, B.A., and P. A. Raghunathaswami Ayyangar, Dip. Ag., Assistants to the Government of Agricultural Chemist, Madras.	Ditto.

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Agricultural Chemistry.—concld.		
The improvement of the indigenous methods of *gur* and sugar making in the United Provinces. Pusa Agricultural Research Institute Bulletin No. 82. Price As. 8 or 9*d.*	W. Hulme, Sugar Engineer Expert to the Government of India, and R. P. Sanghi, Sugar Chemist, Nawabganj Experimental Factory.	Government Printing, India, Calcutta.
The loss of indigo caused by bad settling and the means of obviating this. The use of *dhak* gum—its effect on yield and quality. Pusa Agricultural Research Institute Indigo Publication, No. 3. Price As. 4 or 5*d.*	W. A. Davis, B.Sc., A.C.G.I., Indigo Research Chemist to the Government of India.	Ditto.
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No.	Title	Author	Where published
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77	Annual Report of the Imperial Bacteriological Laboratory for the year ending 31st March, 1918. Price As. 4 or 5*d.*	Issued by the Agricultural Adviser to the Government of India, Pusa.	Government Printing India, Calcutta.
78	Annual Report of the Bengal Veterinary College and of the Civil Veterinary Department, Bengal, for 1917-18. Price As. 9 or 10*d.*	Issued by the Civil Veterinary Department, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
79	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1917-18. Price As. 8 or 8*d.*	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
80	Annual Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for 1917-18. Price As. 10 or 10*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing Punjab, Lahore.
81	Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1917-18. Price As. 14 or 1*s.* 3*d.*	Issued by the Civil Veterinary Department, Madras.	Government Press, Madras.
82	Faulty flaying of hides and the branding of cattle. Madras Department of Agriculture Leaflet No. 5 of 1918.	Issued by the Department of Agriculture, Madras.	Ditto.
83	Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1917-18. Price R. 1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
84	Report of the Civil Veterinary Department, Assam, for 1917-18. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
85	Report of the Civil Veterinary Department, Burma, for the year ending 31st March, 1918.	Issued by the Civil Veterinary Department, Burma.	Government Printing Burma, Rangoon.
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